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USER'S GUIDE
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NAVY WATER CONSERVATION GUIDE FOR SHORE ACTIVITIES

by
Theresa Hoffard
Daniel T. Magro
Maria A. Zendejas

July 1997

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Water conservation is essential to mission readiness in the Navy. Without adequate water supplies no mission can continue, and with demand for fresh water supplies ever increasing with population, the need to conserve grows. Consumptive Use Permits and restricted availability to new water sources, already a reality for many installations, will soon encompass the entire Navy. Conserving this life sustaining asset will save money, project a positive image to the local community, and help preserve the environment and economy of your neighborhood.

This Guide will assist your command in managing and conserving your water assets as well as complying with Executive Order 12902 which, among other things, requires that water conservation measures with suitable payback be implemented at all federal facilities. It is targeted towards the installation planners and utility supervisors tasked with water conservation and management, but can also be used by anyone interested in water conservation.

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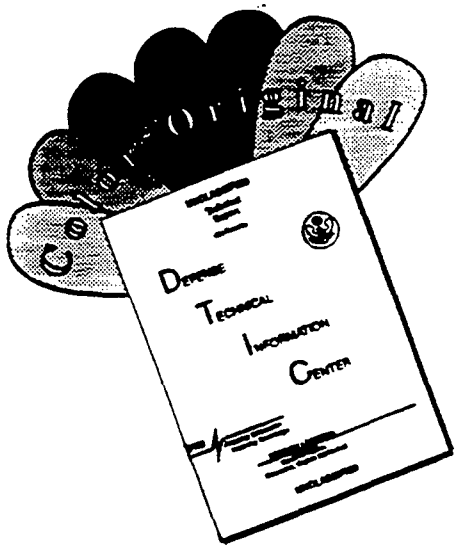

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Navy Water Conservation Guide For Shore Activities

Water conservation is essential to mission readiness in the Navy. Without adequate water supplies no mission can continue, and with demand for fresh water supplies ever increasing with population, the need to conserve grows. Consumptive Use Permits and restricted availability to new water sources, already a reality for many installations, will soon encompass the entire Navy. Conserving this life sustaining asset will save money, project a positive image to the local community, and help preserve the environment and economy of your neighborhood.

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Navy Water Conservation Guide For Shore Activities

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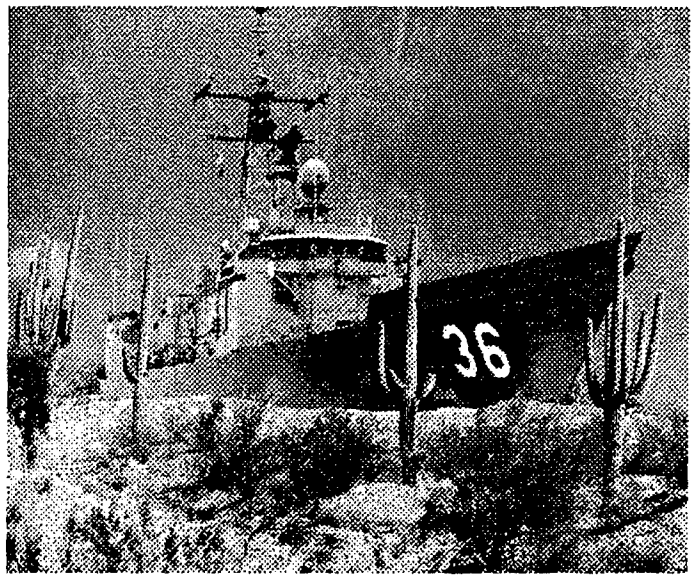


"Where would the Navy be without water?"

CHAPTER 1
INTRODUCTION

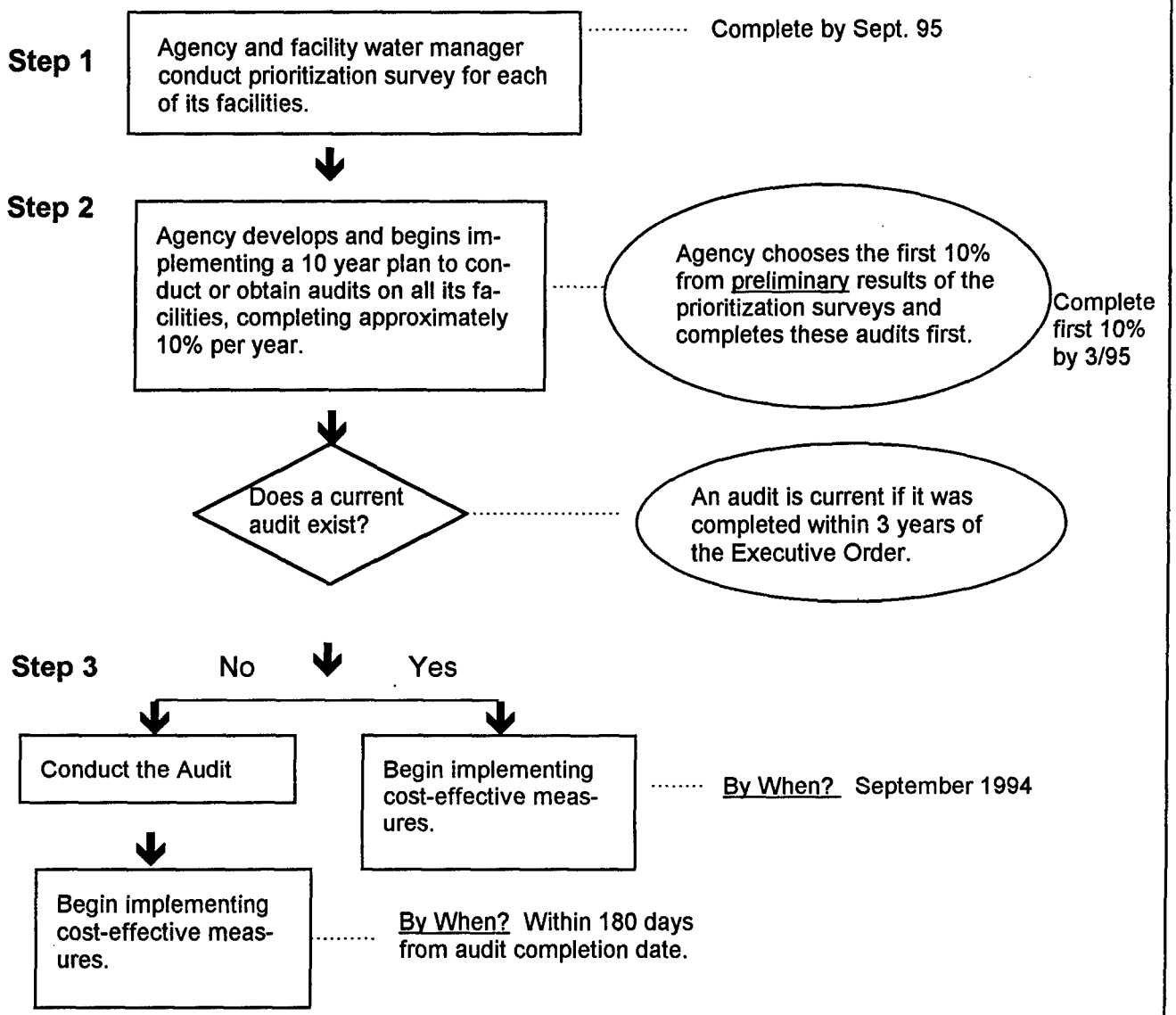
A. Water Conservation - The Law of the Land!

In March of 1994, Executive Order 12902, "Energy Efficiency and Water Conservation at Federal Facilities," was issued as a follow-up to the Energy Policy Act of 1992. Executive Order 12902 states that all federal agencies are to take specific actions to conserve energy and water at their facilities. The Executive Order mandates that agencies within the federal government reduce energy consumption in federal buildings by 30% from 1985 levels by the year 2005. Although the requirements described for energy conservation are more detailed, the Executive Order provides inclusive requirements for water conservation. Figure 1-1 shows a flowchart presenting the following requirements in a step-wise fashion:

1. All federal agencies are required to conduct a prioritization water survey by September 1995 for each of the facilities the agency manages.

2. Based on the prioritization survey results, each agency must develop and implement

Figure 1-1: Flowchart Showing the Requirement of Executive Order 12902 for Water Conservation



DEFINITIONS:

Agency - an administrative division of the United States government with specific functions and facilities under its control.

Federal Facility - any building or collection of buildings, grounds, or structures which is owned, held, or leased by any Federal agency of the United States.

Prioritization Survey - a rapid assessment that will be used by a Federal agency to identify those facilities with highest priority water conservation projects based on the degree of cost effectiveness.

Facility Audit - a survey of a facility that provides sufficiently detailed information to allow an agency to enter into water savings performance contracts or to invite inspection and bids by private upgrade specialists for direct agency-funded water efficiency investments.

Cost-Effective - provides a payback in less than 10 years, pursuant to 42 U.S.C 8254 and 10 CFR 436.

a 10-year plan to conduct or obtain facility audits.

10% of all facilities under the agency's jurisdiction must have been audited by March 1995, with an additional 10% each subsequent year.

An audit can be considered current if performed within three years previous to March 1994 (the date of the Executive Order).

3. For current, existing audits, implementation of cost-effective measures must have begun in September 1994.

   For new audits, implementation of cost-effective measures must begin within 180 days of the audit completion date.

Appendix A contains a summary of Executive Order 12902 as it applies to water conservation.

Fortunately, the Executive Order also states how agencies and you, the Navy facility water manager, are to be assisted by the Department of Energy (DOE) and the General Services Administration (GSA) in completing the above daunting task! The role of DOE is to take the lead in implementing Executive Order 12902 through FEMP, the Federal Energy Management Program. The FEMP office was established within DOE over a decade ago to facilitate improvement of energy and water conservation practices among federal agencies, and to coordinate and support the development and application of tools, techniques, and strategies to improve energy and water efficiency in the federal sector. According to the Executive Order, DOE, GSA, and each Federal facility has its own unique role in implementing water conservation. In the Navy, the Naval Facilities Engineering Command (NAVFACENGCOM) plays the key role. Figure 1-2 shows the roles of NAVFACENGCOM, DOE, GSA, and each Federal facility in federal energy and water management.

In Appendix B, you will find a list of helpful contacts for energy and water conservation issues. Contacts at the Naval Facilities Engineering Service Center (NFESC) can assist you in your efforts to develop facility water and energy conservation project and forward recommendations for funding to NAVFAC. The NFESC also assists facilities in the technical issues of implementing such conservation projects. You will learn more about NFESC's role in Chapter 3.

B. Water Conservation Guide Layout

The *Navy Water Conservation Guide* is intended to aid you in complying with Executive Order 12902 as it relates to water conservation by identifying and describing the steps for implementing a successful water conservation program. The *Navy Energy Manager's Handbook*, published in July of 1994, provides in-depth information on energy conser-

Figure 1-2: Roles of DOE, GSA, NAVFACENGCOM and others in Water Conservation

DOE Department of Energy	GSA General Services Administration	NAVFACENGCOM Naval Facilities Engineering Command	Facility

♦ Implement EO 12902 through FEMP.
♦ Develop indicators of water efficiency, consumption, and cost.
♦ Prepare report on issues of instituting life cycle analysis.
♦ Develop recommendations to assist agencies in eliminating procurement barriers to implementing EO.
♦ Develop agency technical assistance services to identify/implement water conservation opportunities.
♦ Explore ways to stimulate water conservation in federal facilities (Sec. of Energy with GSA).
♦ Develop program to train/support agency water conservation project teams.
♦ Through FEMP, develop an agency service program and assign account managers to each agency.
♦ Identify advanced technologies not yet on the market.
♦ Provide guidance on the retirement of older water using equipment (With GSA).
♦ Provide guidance on or make available:
  ♦ Water and energy consumption and savings relationships.
  ♦ Innovative water conservation funding methods.
  ♦ List of national water service companies.
  ♦ Information on capabilities and technology through National Energy labs.
  ♦ List of qualified water efficiency contractors for federal projects.
	♦ Determine GSA contracted utilities which perform no-cost audits.
	♦ Determine utilities which offer demand-side management services and incentives.
	♦ Develop efficient procurement techniques, methods, and contracts.
	♦ Provide information on specific water conservation products.
		♦ Comply with DOD (deemed the "agency") in carrying out EO 12902.
		♦ Manage ECIP and FEMP funding for water and energy conservation projects.
		♦ Recommend projects to Secretary of Defense for FY funding.
		♦ Issue Navy policies and guidelines to implement water conservation projects.
		♦ Develop Navy-wide execution plan for water projects.
			Obtain assistance as needed from DOE, GSA, NAVFAC, NFESC etc, to:
			
			♦ Develop a facility water conservation plan.
			♦ Conduct facility water audit.
			♦ Determine water conserving measures.
			♦ Implement water conservation measures.

vation management at federal facilities. The *Navy Water Conservation Guide* is similar to the *Navy Energy Manager's Handbook* in that it provides information on general procedures and key personnel. However, it only addresses these issues as they specifically relate to water conservation. This guide therefore is more condensed and brief on topics that are found in the Energy Handbook. You will want to refer to the *Navy Energy Manager's Handbook* for general information as you read this guide.

Chapter 2 of this guide is an overview of the steps to develop a water conservation plan at your facility. Chapter 3 goes in-depth into the process by which water conservation projects are documented for submittal, and funding. Chapter 4 discusses various water saving devices and technologies available, and Chapter 5 describes software tools available to aid you in water resource analysis and planning.

Appendices are included in the back with helpful contacts, sample project submittal packages, and other useful information.

C. A New Outlook on Water

Water and its future availability have historically been taken for granted in the United States. After all, water has always been a cheap commodity in the U.S., and the incentives for conserving this seemingly abundant resource have been minimal. However, with the population explosion in the second half of the twentieth century, we are now taking a new view of our water resources.

Consider the following facts: Almost three-fourths of the earth's surface is water, yet 97% of the earth's water supply is ocean (salt) water. The remaining three percent is fresh, but two-thirds of this is in the form of ice caps and glaciers! The U.S. alone withdraws over 450 billion gallons of ground and surface water a day, according to the U.S. Geological Survey, at least three times the amount of water as the rest of the world.

Beyond laws and regulations, the conservation of water is imperative to the future economic, social, and physical health of our country and world. Water is used in every facet of life, from agriculture and industry to residential and recreational.

As well as the benefit of securing the world's water supply for the future, other important benefits can be derived from water conservation. Proper water management can lead to substantial financial savings. In addition, when water is conserved, energy savings are often observed due to lessened energy demands for treating, heating, or cooling the water.

D. Water Usage in the Federal Government

The federal government has not been exempt from the past practices

of water overuse, abuse, and apathy. DOE estimates that water use in the federal government exceeds 23 billion gallons a year with costs for water and sewage exceeding $60 million per year. Yet, most federal agencies do not know how much water they use, what the water is being used for, or the cost of that water.

Within DOD and the Navy, this has also been the case. For example, do you know how much water your facility consumes per year, or the cost of that water? Take a look at Figure 1-3 which shows many different uses of water at a typical Naval installation. Then turn to Figure 1-4 which shows a compilation of water costs at several different Naval bases. Are the numbers surprising?

With the enactment of Executive Order 12902 and its preceding congressional laws, as well as the realization that fresh water is a precious and limited resource, the implementation of the principles of water conservation at your Navy facility will become part of your regular facility management routine.

E. Typical Water Uses

Figures 1-5 and 1-6 show a typical breakdown of water consumption for residential houses and office/administrative buildings, respectively. These particular percentages represent water usage for the city of San Jose, California, but should closely resemble water usage in your location. Ordinarily, Naval installations will have a majority of residential or administrative buildings. Notice that for both, the largest use of water is for personal hygiene, specifically, bathroom and restroom use. These areas are the first targets for water conservation. Other areas include landscaping, cooling and heating equipment, and laundries.

Figure 1-3: Typical Water Use at Naval Facilities

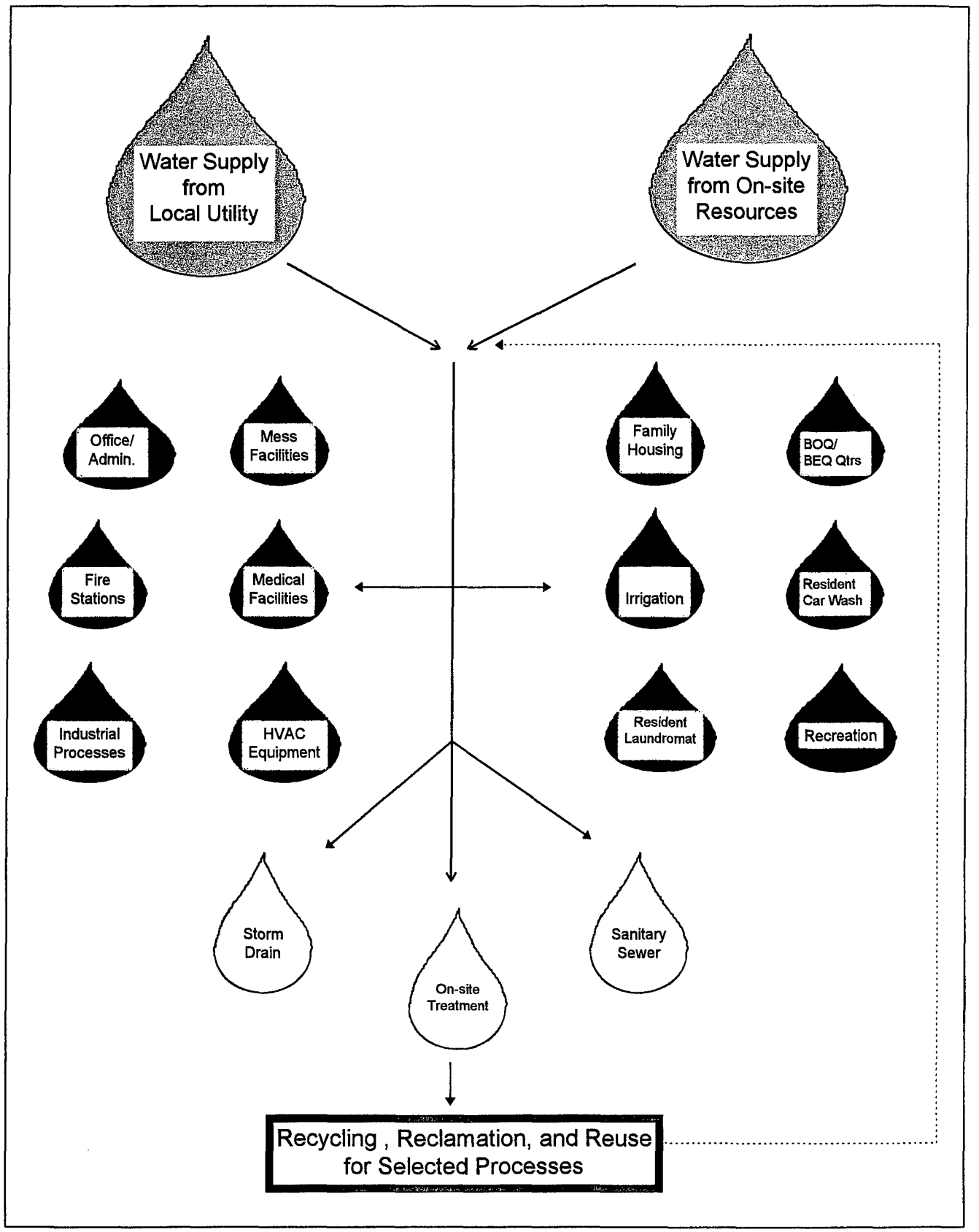


Figure 1-4: Average Water Cost (FY93) for Selected States

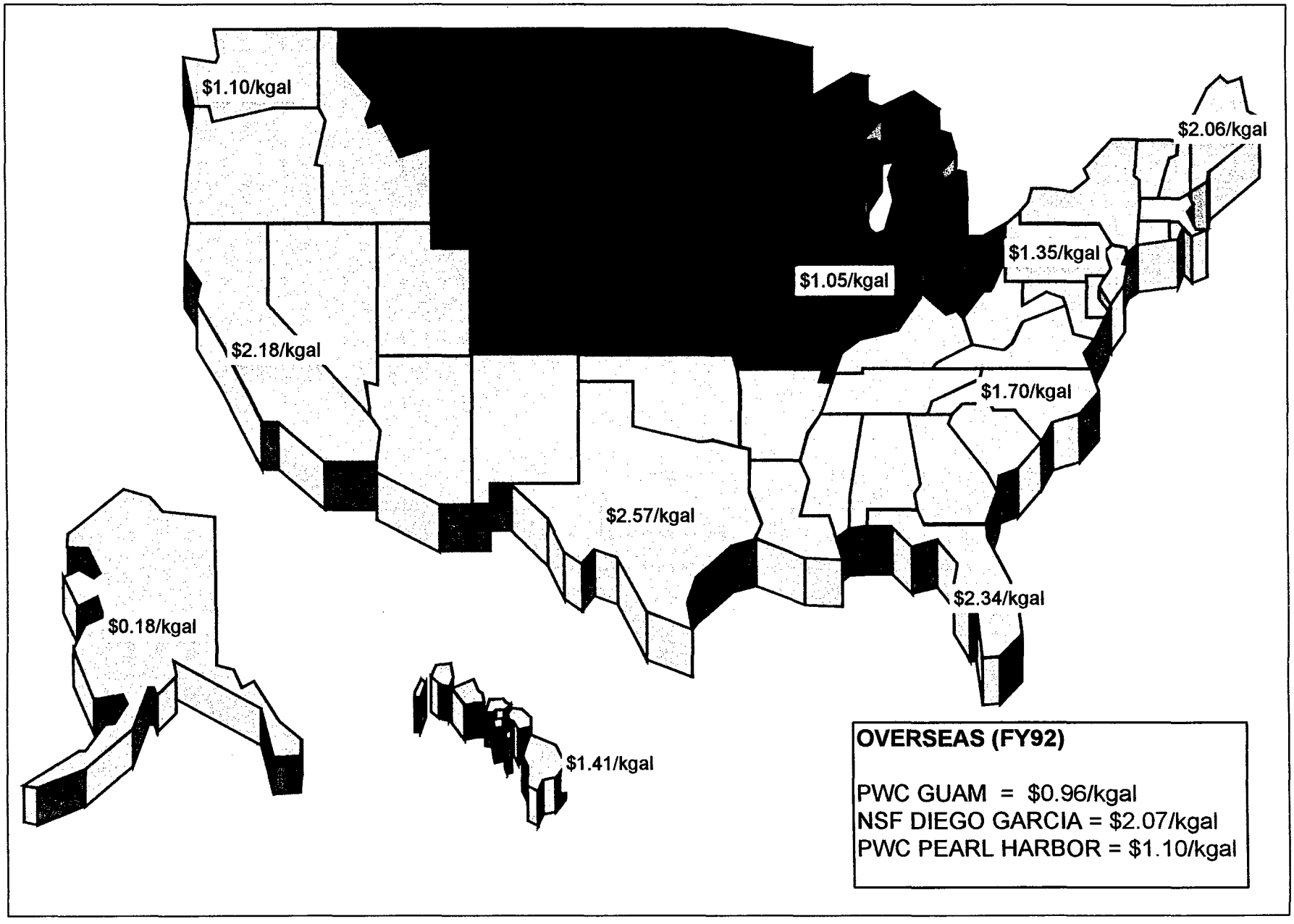


Figure 1-5: Typical Water Usage in Family Housing

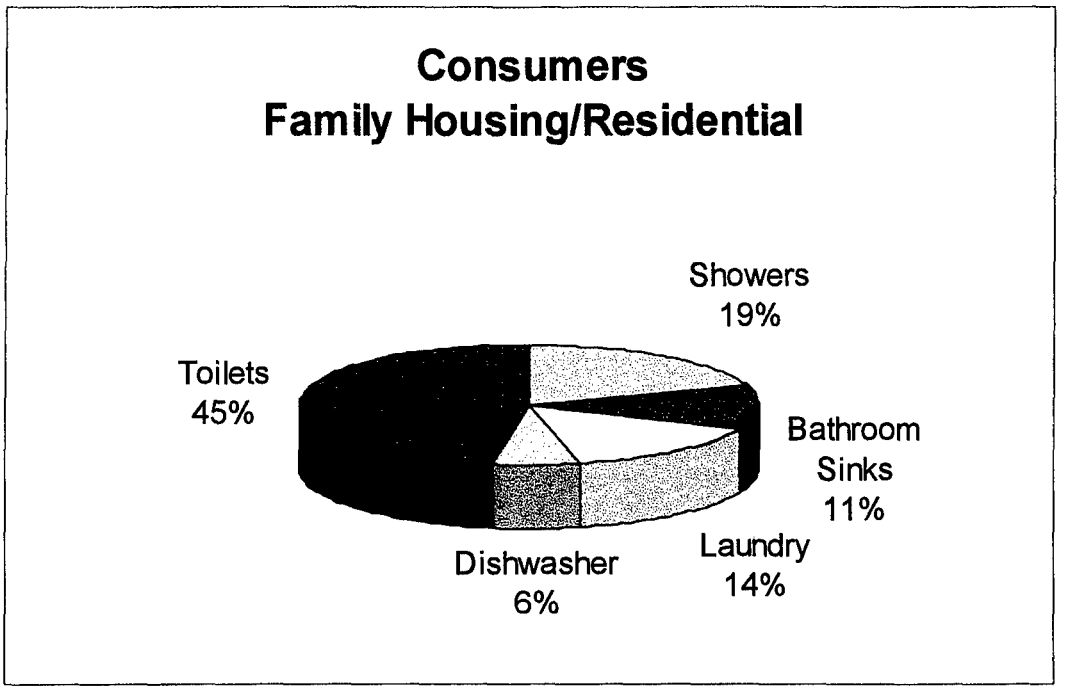
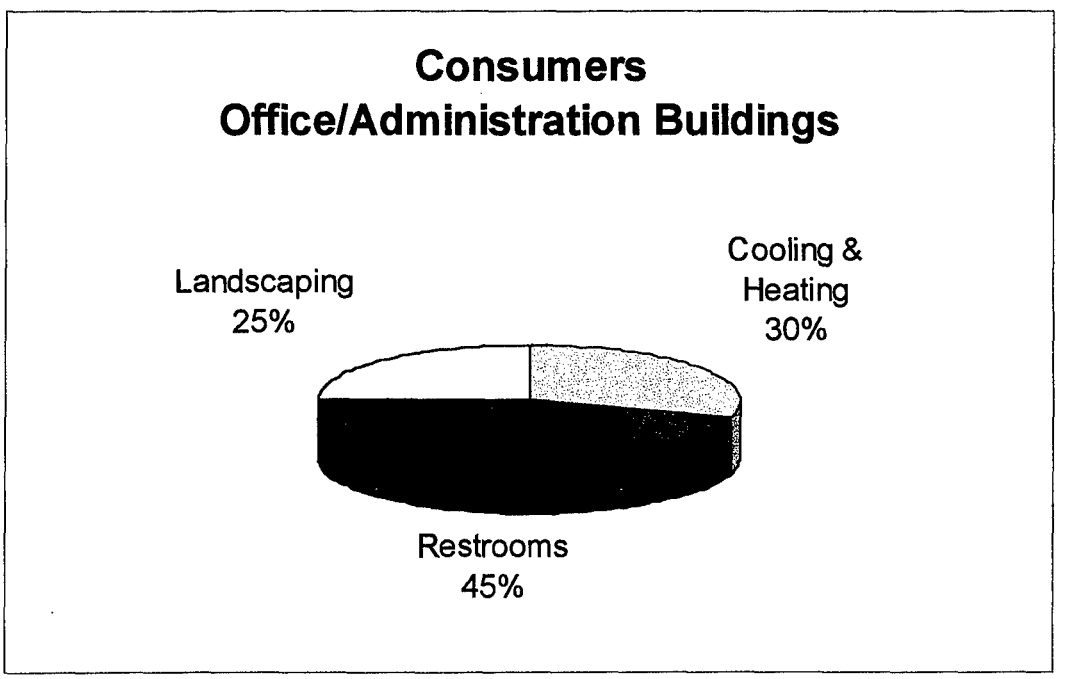


Figure 1-6: Typical Water Usage in Office/Administrative Buildings



CHAPTER 2
DEVELOPING A WATER CONSERVATION PLAN

Presented below are the individual steps for the development of a water conservation plan for a Navy facility. Following these steps will assist you in complying with the requirements of Executive Order 12902, as well as introduce your facility to the long-term benefits of water and utility savings and efficiency.

A. The Facility Audit

A comprehensive facility water audit is the process by which all water-consuming equipment at a facility is monitored to determine water usage, water losses, and the costs associated with each. The types and condition of the equipment are also determined. The survey results allow you, the Navy facility manager, to make informed and appropriate decisions about implementing cost-effective water conservation measures. In short, a water audit allows you to identify, quantify, and verify your facility's water use.

The facility audit should not be confused with the "prioritization survey" described in Executive Order 12902. The prioritization survey is performed at the agency level, that is, DOD. It is an assessment of the overall picture of water use and losses within DOD. It targets installations for further investigation, identifies any exempt facilities, and establishes highest priority facilities for comprehensive audits. The facility audit, on the other hand, is a detailed study conducted at the facility level and is specific for that facility.

Besides being a requirement set forth in the Executive Order, an audit is beneficial for determining and reducing water losses, increasing knowledge of the facility's distribution system, and achieving financial savings.

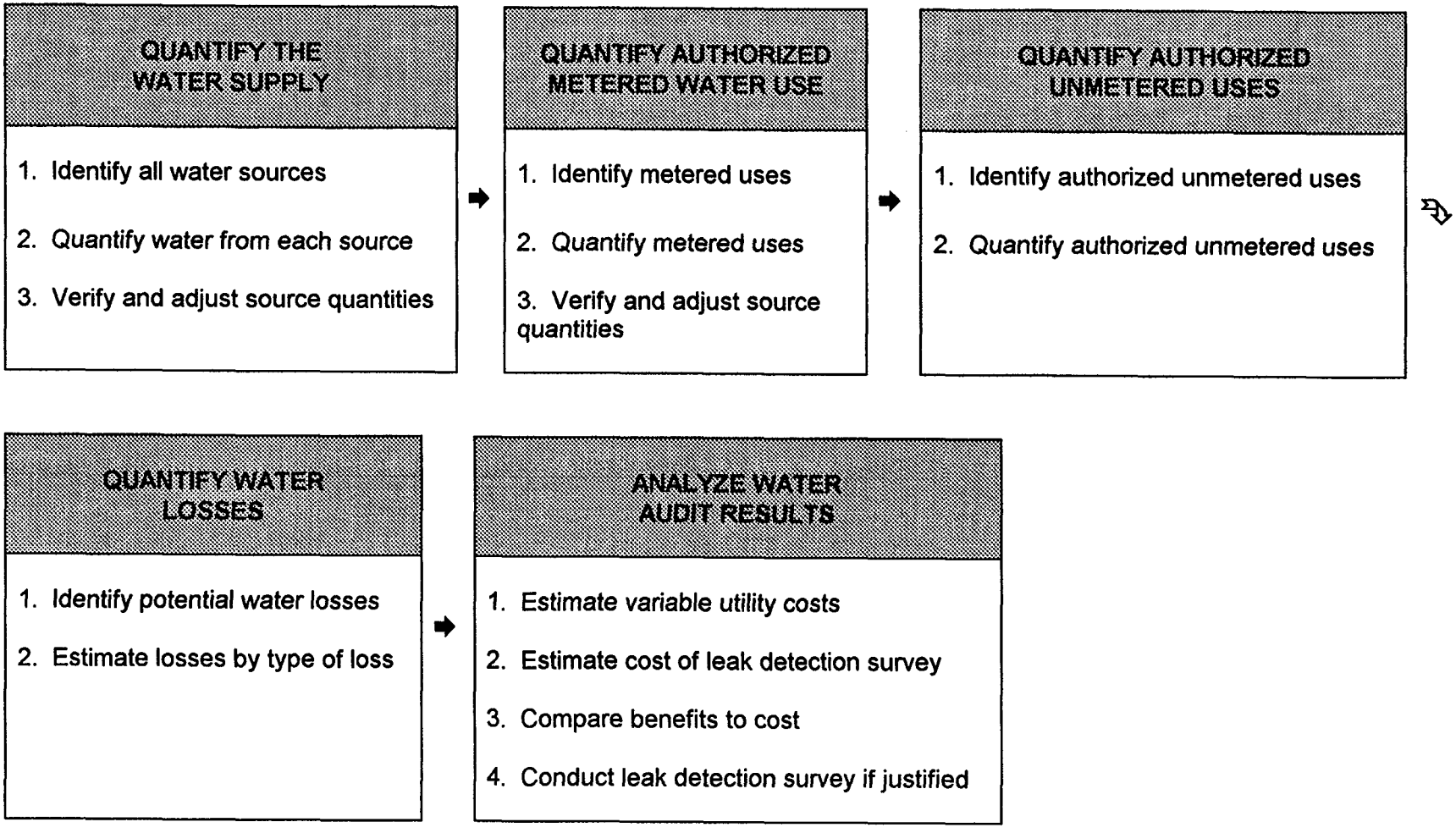
Conducting an audit of one's facility is a significant undertaking involving the need for labor, time, and materials. There are many tasks which must be performed to obtain meaningful data about a facility's water use. You may wish to obtain assistance from NFESC, the utility company, or an A/E firm. NFESC also offers a leak detection survey service to determine water loss from leaks at your facility. Refer to Appendix B.

NFESC has also developed a series of Water Conservation Survey forms (see Appendix C) which will help you organize your audit information.

Also, commercial (and DOD) publications are available which give detailed instructions on these tasks which you may find beneficial. See the list of references in Appendix D for titles.

Figure 2-1 shows the general parts of a water audit. Typical Naval installations will have a majority of unmetered water use. In this guide,

Figure 2-1: Steps In A Water Audit



the primary tasks of an audit are divided into three areas:

1) Gather Existing Information:
   - Any maps or floor plans showing plumbing or equipment locations.
   - Past water and sewage bills from the utility, as well as the identity of the utility.
   - Any previous water conservation measures (such as retrofits) already implemented; also any previous water audit data.
   - List of current water-using equipment, their manufacturers, and the number of each type (e.g., toilets).
   - Number of employees, their working schedules, and building locations.

2) Conduct the Audit:
   - Assemble qualified personnel for a survey team and assign the tasks.
   - Seek the assistance from the utility - they may be able to help conduct the audit.
   - Choose the appropriate unit of measure for each device and have survey personnel use it consistently in any calculations (e.g., GPF - gallons per flush for toilets, GPM - gallons per minute for faucets).
   - Measure incoming water supply flows (it may not match the utility's figures).
   - Measure outgoing water flows, if possible.
   - Physically observe and identify all water consuming equipment. Determine their daily usage rate.
   - Determine the amount of water consumption for each device during use. Use meters as appropriate.
   - Use leak detection program to determine water losses.
   - Identify any other observable losses of water

3) Analyze audit results:
   - Compare the measured water consumption (per use and daily consumption) of the devices to any available manufacturers' claims.
   - Calculate the cost of the water consumed by each device at the facility and the cost of "lost" water.
   - Identify recoverable leakage and any corrective measures for them.

Pay close attention to calculating the COST of the water. Remember to include production and/or purchase cost, water treatment costs (e.g., chlorine), distribution pumping costs, and sewage treatment and disposal costs (unless, of course you are considering irrigation water which never goes to the sanitary sewer). Knowing your water costs gives you the knowledge and power to correct unfavorable situations to save water and money.

B. Exploring Options

Next its time to examine potential water conservation measures for the

facility based on the audit results. Chapter 4 contains information on numerous water conserving devices and techniques to assist your facility in selecting the most appropriate cost-effective options.

There are several issues that should be addressed when one considers which options are suitable for implementation:

a) Long Term -vs- Short Term Reliability - Consider how long the conservation measure will remain reliable. Short term approaches may not be cost-effective in the long run.

b) Capability-Building - Consider adding programs as they become more economically attractive, that is, as they become cost-justified. Don't try to implement every technique right away if it is not cost effective to do so.

c) Avoid Lost Opportunities - Make sure to implement enough of the right measures when the chance arises.

d) Consider Social Acceptability - Make sure that the target audience is going to accept and support your water conservation initiatives. Without social acceptance, your project will be severely hampered.

e) Payback Gaps - A Life Cycle Cost (LCC) Analysis will help determine the payback gap between the cost of installation and maintenance of the measures, and the resulting savings. An LCC analysis is required when submitting a military construction project to NAVFACENGCOM for approval. See NAVFAC handbook P-442 for assistance in performing LCC analyses. Several publications from NIST (the National Institute of Standards and Technology) may also be helpful: NIST Handbook 135 *Life-Cycle Costing Manual for the Federal Energy Management Program*, NISTIR 4942 *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense*, and NIST *Building Life Cycle Cost (BLCC) Computer Program.*

C. The NAVY Submittal Process

Chapter 3 contains a details on the NAVY submittal process for water conservation projects. Keep in mind that some water conserving measures may not qualify as a "project" in terms of being centrally funded. These measures, called "low cost/no cost," are discussed in Chapter 4. They are not suitable for the project submittal process, unless they can be combined to reach a threshold funding level (see Chapter 3). Usually, the facility itself must fund low cost/no cost projects.

D. Implementation

Once the water conservation measures have been selected and ap-

proved and the required funding is available, it is time to implement the measures. You may choose to carry out the implementation with in-house personnel, the public works center, and/or contractors. The implementation plan can be divided into three tasks:

1) Employee and Resident Education: A facility's water conservation program will only be successful with participation from the people impacted by the measures. Get the word out to building occupants and visitors about the facility's water conservation program and what it involves. Establish an education program which provides background information on water conservation and why it is important to the facility. Use visual aids such as posters, signs, flyers, videos, and demonstrations to show the environmental and financial benefits of conserving water. Train building occupants on the correct way to use the water measures, such as low flow toilets. Dispel misconceptions that water efficient devices "don't work as well" as the original fixtures. Explain that, when used properly, these devices are capable of providing the same level of service as the old devices, while saving water.

2) Developing a timeline: Prioritize the water conservation measures - determine which ones should be installed first, and the time required to install each measure. Factors such as work disruption for building occupants, ease of installation, and availability of labor to complete the installations should be considered. Allow enough time to complete each installation. Consider scheduling for potential simultaneous installation of more than one measure so that if one installation is halted or delayed, the other installations will not be held up.

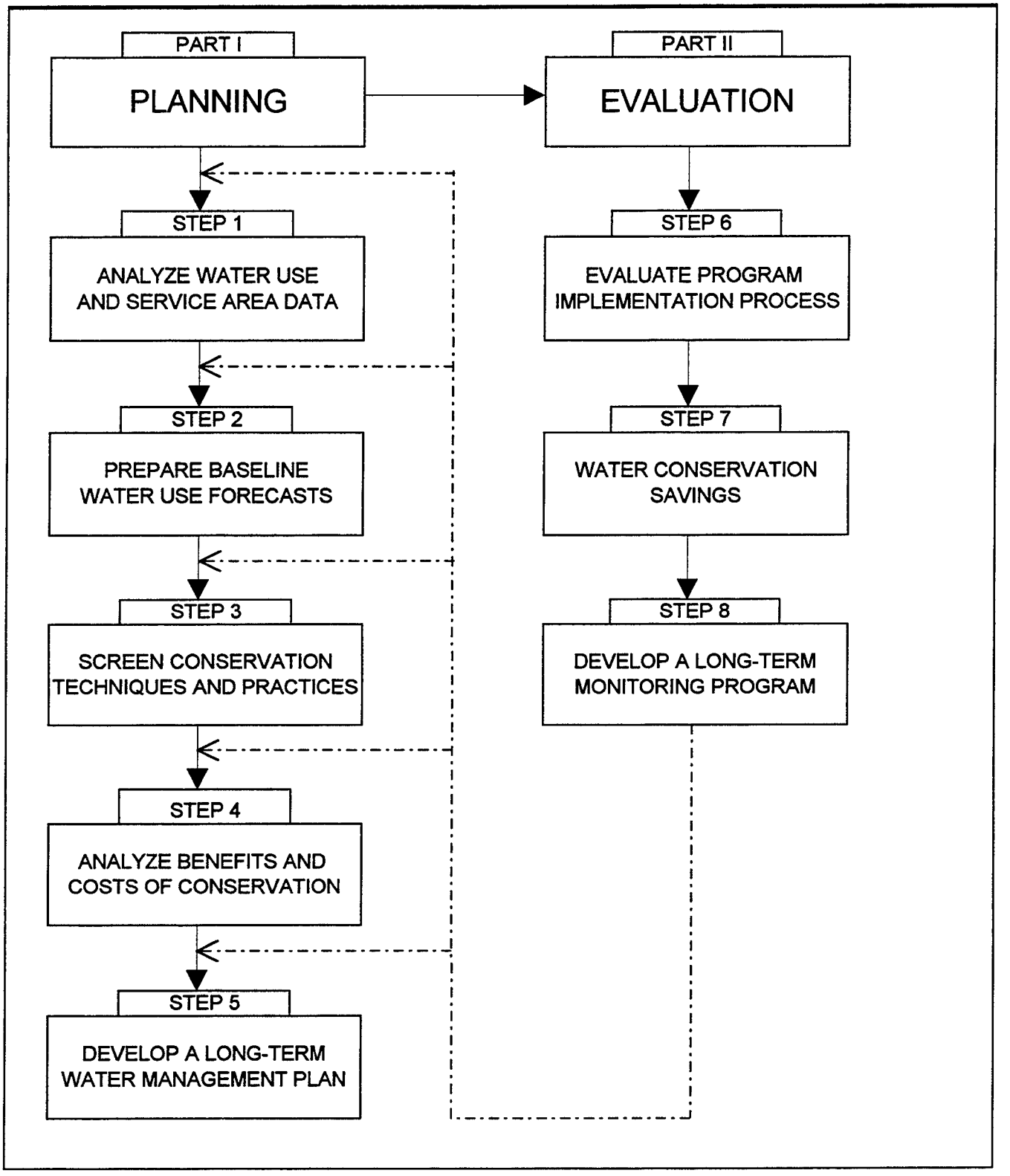
3) Monitoring and updating: Monitoring the measures will determine if they are working, and will identify problems which may arise. Monitoring should include the following:

- Check water usage regularly for each installed measure and compare to the pre-installation consumption (determined during the audit).
- Check water and sewage bills for decreases in overall consumption and costs.
- Calculate the savings in terms of water and costs.
- Make sure maintenance personnel are assigned to monitor the installed equipment and repair it as needed.

Consider Figure 2-2 which presents a flowchart of the overall process of implementing a water conservation management plan.

Remember that it will be necessary to keep the audit up to date. Annual updates will provide information to help you monitor progress, make adjustments and corrections, and identify further areas which would benefit from water conserving measures.

Figure 2-2: Conservation Planning and Evaluation Procedures



CHAPTER 3 THE SUBMITTAL PROCESS

A. The Funding Process

Once you have performed the facility audit and determined which water conservation projects to implement, you will need to arrange for funding. This chapter presents a summary of the submittal process required to obtain funding for water conservation projects at your facility.

Although most water conservation measures require funding to implement, some water conservation methods can be considered "low cost/no cost" projects. This means that they cost less than $50,000 and do not qualify as a project in terms of receiving central funding. Individual activities must fund these projects.

Examples of "low cost/no cost" water conservation measures include:

- Repair of small leaks.
- Maintenance of toilets - small part purchases as required.
- Reducing bleed off of cooling tower to minimum acceptable levels.
- Altering irrigation schedules from afternoon to morning.

For projects which do require significant funds (e.g., > $50K), there are two major funding programs centrally managed by DOD: ECIP and FEMP.

ECIP, the Energy Conservation Investment Program, can be used by all Navy activities for projects which are construction in scope and are greater than $300K in cost. ECIP projects are defined as those which require more than one year to execute and demand a significant amount of design.

FEMP, the Federal Energy Management Program, covers eligible projects not funded through ECIP or claimant programs. Most water conservation projects are covered under FEMP, rather than ECIP, because they generally are not construction in scope.

Deciding on which funding program to use (FEMP or ECIP) is not usually done at the submittal stage. The submittal process for both programs is identical, and the decision on which funds to use is typically done by NAVFACENGCOM after the project has been submitted and approved.

FEMP money is a type of O&M funding (Operations & Maintenance). DOD does not currently have the authority to transfer FEMP money to MILCON, BUMED (Bureau of Medicine and Surgery), or Family Housing accounts. Therefore, FEMP funding is NOT available for Family Housing or BUMED projects.

This does not mean that projects in these areas are not valid or shouldn't be encouraged. It simply means that these projects are funded from separate funding accounts. In the case of Family Hous-

ing, water conservation retrofits are programmed into the Whole House Repair Program and accomplished at the same time as other major renovations to minimize the inconvenience to the residents of housing. You should contact your facility housing manager for more information if your housing areas have water saving opportunities.

Outside of the Family Housing and BUMED arenas, to be eligible for funding from either ECIP and FEMP, the project must:

1) Be greater than $50,000 in total cost. Projects under $50,000 are considered "low cost/no cost" and usually must be funded in-house, but may sometimes be grouped together and funded as one large project.

2) Have an acceptable "Savings to Investment Ratio" or "SIR". Since there is a limited amount of funding available each year, the projects submitted must compete against each other for funds. Thus, the better the SIR value, the better the chances for funding approval.

3) Have a payback of 10 years or less.

4) Meet DOD funding obligation schedules: FEMP funds must be obligated in the same fiscal year in which approved.

5) Conserve water.

If you have several small projects and are considering combining them, then they should have some common thread amongst them. This could be several projects (e.g., low-flow toilets, energy efficient lighting, and variable speed motors) all within the same facility. Or a number of projects in a number of different facilities, all of which conserve water.

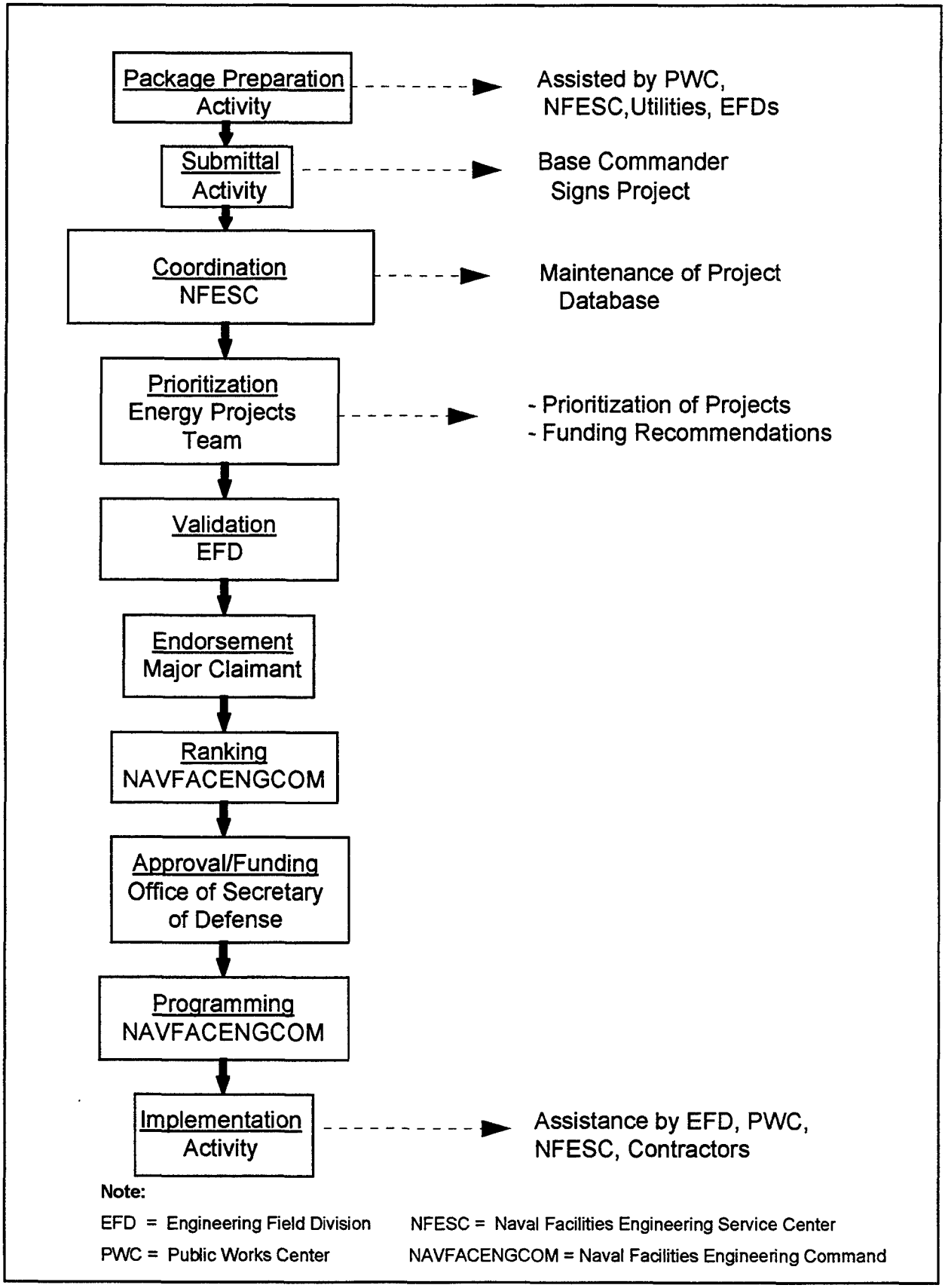
In general, related projects which conserve water and which have satisfactory economic analyses will be accepted for consideration. For example, a toilet retrofit and a landscape project might not be directly related, but if they both conserve water and have good economic analyses they will likely be considered for funding approval under FEMP.

All projects which qualify for ECIP or FEMP funding must be submitted to NAVFACENGCOM for approval. Figure 3-1 is a project programming flowchart showing the approval process. The process includes several key players or organizations, each with a specific role in funding your project. If you are unfamiliar with any of these organizations or their interest in your water project, it will be helpful to review them now. Below are the key organizations and a description of their roles in the funding process. For more information, see the Navy Energy Manager's Handbook.

The Activity

Prepares and submits water projects to claimant or NFESC via the geographic EFD.

Figure 3-1: Navy Water Projects Programming Process



Obtains assistance from the EFD, PWC, pertinent utilities, and NFESC to prepare the project submittal package.

Provides a maintenance program for the installed project.

EFD - Engineering Field Division

Performs technical evaluations on submitted and programmed project packages based on technical assumptions, water and cost savings, and construction cost estimates.

Provides assistance in identifying, developing, and auditing FEMP and ECIP projects.

Executes the engineering contract efforts requested by the activity.

Claimant

Endorses EFD validated project packages depending on funding requirements, future use of the facility, and concurrence with claimant policies and directives.

Provides assistance to installations by using O&M standards, management guidance, and engineering expertise to identify and implement energy and water conservation efforts.

NFESC - Naval Facilities Engineering Service Center

Reviews project submittals for consistency in technical and LCC suitability and prioritizes them by SIR and payback.

Enters project data into a computer database and maintains the database for tracking and reporting of projects. Provides technical and engineering services as well as information resource management in support of the Navy's energy and water conservation programs.

Energy Projects Team

Made up of energy personnel from the EFD's, PWC's, NFESC and NAVFACENGCOM.

Prioritizes projects by SIR and payback and recommends projects to NAVFACENGCOM for funding

NAVFACENGCOM - Naval Facilities Engineering Command

Recommends projects to OSD (the Office of the Secretary of Defense) for FY funding.

Centrally manages ECIP and FEMP funds to execute selected projects.

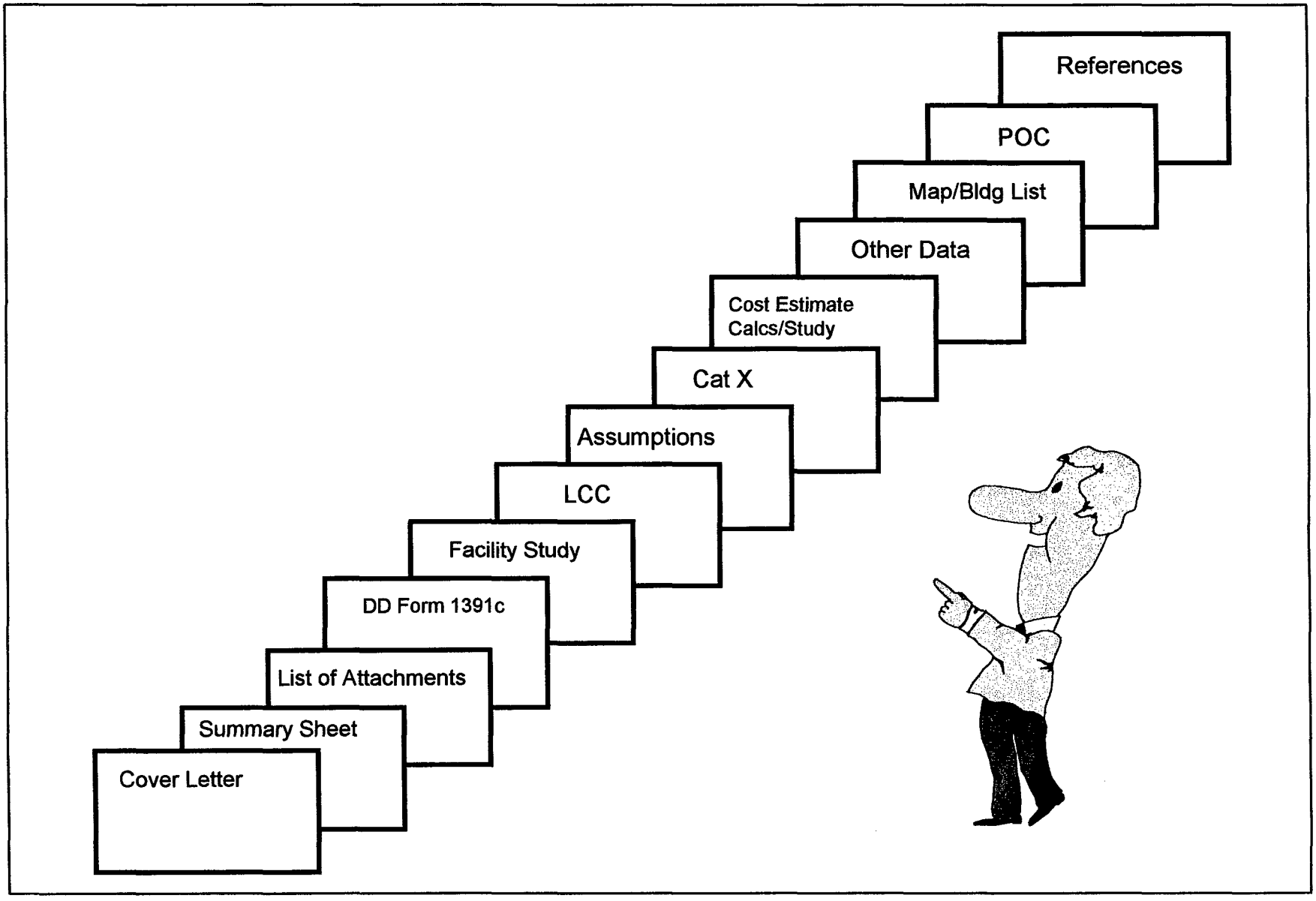
Develops and issues Navy policies and guidelines to execute water projects.

Develops Navy-wide execution plan for water projects.

B. Components of the Water Project Package

Figure 3-2 shows the components which make up a water project submittal package. There are several different parts. Each part is de-

Figure 3-2: Components of the Water Project Package



scribed for you below. Properly completed sample submittal packages for water conservation projects (excluding cover letters) are included in Appendix E.

Part 1: Cover Letter, Summary Sheet and List of Attachments:
The cover letter will be addressed from your activity commanding officer to the NFESC (Code 22) with a copy to your EFD and major claimant. It serves as an introduction to the submittal package with a brief description of the project.

The summary sheet is just that, a summary of the information in the package, with financial information from the completed LCC analysis spreadsheet. (See Appendix E)

After the summary sheet, a list of the submittal package contents is included. (See Appendix E) Notice that there are distinct attachment categories.

Part 2: DD Form 1391: Each project is documented on a DD Form 1391 which serves as the principal programming document for the tracking of the project. The 11 parts of a DD Form 1391 are described in detail in NAVFACINST 11010.44E, the Shore Facilities Planning Guide. Blocks 1-4 and 6-9 are to be filled in using capital letters. "NAVY" should be typed in Block 1. Block 5 is left for NAVFACENGCOM use. Block 6 requires the five digit category code number from NAVFAC P-72 for the facility. Block 7 requires a project number consisting of the letter "P" for project and then three digits. You may choose your own numbers but remember to retire the "P-number" when the project is completed or deleted from the program. This number serves to identify a project throughout its life and so it must be unique. Block 8 is the estimated cost of the project in thousands of dollars. Block 9 is the itemized cost estimate derived from the Facility Study (DD 1391c). The "Total Request" entry should be identical to the estimated cost in Block 8. Block 10 requires a brief but accurate outline of all the principal features of the project and Block 11 describes the facility requirements which necessitate the project. (See Appendix E)

Part 3: Facility Study: The Facility Study is DD Form 1391c (see NAVFACINST 11010.44E) and consists of 32 parts. Figure 3-3 shows a blank DD 1391c. You should include in this study, referrals to the economic analysis (LCC) and the categorical exclusions statement.

Part 4: Life Cycle Cost (LCC): An LCC analysis is required for the project. LCC refers to the amount of dollars to be saved over the life of the project; the "payback period" is also calculated, which is the amount of time to recover the cost of the project. Remember that in order for a project to be eligible for FEMP or ECIP funding, it must have less than a 10 year payback and an acceptable SIR (savings to investment ratio). NAVFAC P-442 Economic Analysis Handbook is the standard reference for completing an LCC. Also, if applicable, use the discount

Figure 3-3: Sample 1391c Facility Study

1. COMPONENT NAVY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
3. INSTALLATION AND LOCATION	4. PROJECT TITLE	

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
PRIMARY FACILITY				
SUPPORTING FACILITIES				
Site Improvements				
TOTAL ENGINEERING ESTIMATE				
OMSI (Type X @ 0.NN%)				
SUBTOTAL				
CONTINGENCY (5%)				
TOTAL CONTRACT COST				
SIOH (6.0%)				
TOTAL REQUEST				
ROUNDED				
EQUIPMENT (from other appropriations)				

10. DESCRIPTION OF PROPOSED CONSTRUCTION:

11. REQUIREMENT: N,NNN AA ADEQUATE: NNN AA SUBSTANDARD: NNN AF

REQUIREMENT:

CURRENT SITUATION:

FORM
DD 1 DEC 76 1391C

Figure 3-3: Sample 1391c Facility Study -- Cont.

1. COMPONENT NAVY	FY____ MILITARY CONSTRUCTION PROJECT DATA	2. DATE
3. INSTALLATION AND LOCATION		
4. PROJECT TITLE		5. PROJECT NUMBER

11. (CONTINUED):

CURRENT SITUATION (contd):

IMPACT IF NOT PROVIDED:

ADDITIONAL:

Economic Alternatives Considered:

a. Status Quo:

b. Renovation/Modernization:

c. Purchase

d. New Construction:

factors from the current version of NIST Handbook 135 Annual Supplement to assist you in your calculations. NFESC has developed a spreadsheet in Microsoft Excel format to make this task easier and to standardize the LCC's submitted for review. A disk copy of the spreadsheet is available from NFESC. (See Appendix B) Your submitted LCC analysis should use this format.

Part 5: Assumptions/ Categorical Exclusion Attachments: A list of any assumptions used in the calculations needs to be given.

The categorical exclusion is a basic reference that is used to cover environmental impact issues for projects that have a minimal impact. An example of a categorical exclusion statement is shown in Figure 3-4.

Part 6: Supporting Savings Calculations/Cost Estimates/ Audit Information Attachments: Include any relevant calculations, especially those used to provide entries for the LCC. Specifically include any savings calculations and the cost estimate form NAVFAC 11013/7. Also include any other pertinent information from conducted studies or audits.

Part 7: Other Data and Information: These attachments may or may not be applicable to your water conservation project. However, any relevant information in the following categories should be attached:

a) Salvage quotes - from the utility or vendor for turning in old equipment or devices.
b) Utility information - cost of the water, whether the cost is fixed or rated, and if rated, how.
c) Rebate information - Programs offered by the utility to offer rebates for installing water conserving devices.
d) Weather data - applicable to an outdoor project such as irrigation, or a construction project.

Part 8: Site Plan/ Building List: Include location lists not addressed in 1391, and also any helpful maps or drawings.

Part 9: POC Personnel: Include the project developer and the project recipient.

Part 10: References: List any reference materials used to provide information for the project package.

When you have gathered all of your information and completed the submittal package, forward it to your activity's commanding officer for approval and signature of the cover letter. The deadline for submitting project packages is March 30th. It is suggested that you submit your package(s) no later than mid February to ensure that funding from the current fiscal year is received.

Remember that MILCON project funding can cross fiscal years, but that FEMP funding must be obligated in the same year its approved.

It may take up to six to eight weeks for your project to be approved, once submitted and another two to three months to receive funding.

Figure 3-4: Categorical Exclusion

Categorical Exclusion for
Special Project R60-94, Lighting Retrofit
Naval Air Station, North Island
San Diego, California

1. PROJECT DESCRIPTION: The project will replace existing fluorescent ballasts and lamps; and mercury vapor lighting with metal halide or high pressure sodium (HPS) ballasts and lamps. Building 11 and 317 are contributing buildings within the National Register-listed NAS San Diego Historic District. Therefore, these two buildings will only retrofit the interior lighting not the exterior lighting.

2. SUMMARY OF IMPACTS:

a) Does not affect public health or safety.
b) Does not involve actions affecting wetlands, endangered or threatened species, historical or archeological resources, or hazardous waste sites.
c) Does not involve affects on the human environment that are highly uncertain, unique or contain unknown risks, or which are scientifically controversial.
d) Does not establish precedents or make decisions in principle for future actions with significant effects.
e) Does not threaten a violation of Federal, State or local law or requirement imposed for protection of the environment.

3. CATEGORICAL EXCLUSION:

The following Categorical Exclusions as listed in reference OPNAVINST 5090.1A dated 01 Oct. 1990, subsection 5-4.2 are applicable.

(6) Routine repair and maintenance of facilities and equipment to maintain existing operations and activities, including maintenance of improved and semi-improved.

(15) Demolition, disposal, or improvements involving buildings or structure neither on nor eligible for listing on the National Register of History Places and when under applicable regulation.

(16) Acquisition, installation and operation of utility and communication systems, data processing cable and similar electronic equipment which use existing right of way, easements, distribution systems, and/or facilities.

4. PROJECT QUALIFICATIONS:

The object of this project is energy conservation and reduction of annual cost for all lighting systems in accordance with NAVFACINST 4101.5 which describes guidelines for Energy Conservation Investment Program (ECIP) for Naval Facilities.

5. DETERMINATION:

Based upon the information presented above, it has been determined that an Environmental Assessment is not required for this contract.

6. CONCURRENCE:

ENGINEER-IN-CHARGE:_____

NAVAL AIR STATION NORTH ISLAND
SAN DIEGO, CALIFORNIA

STAFF CIVIL ENGINEER:_____

CONCUR:_____
DO NOT CONCUR:_____

SOUTHWEST DIVISION, NAVAL FACILITIES ENGINEERING COMMAND

_____
DIRECTOR ENVIRONMENTAL PLANNING

CONCUR:_____
DO NOT CONCUR:_____

COMMENTS:

CHAPTER 4 WATER CONSERVATION OPTIONS

A. Introduction

This chapter previews a wide variety of water conservation options. Each option is presented as an operation and maintenance procedure, a retrofit, or a replacement, as appropriate. Some of these options are simple "low cost/no cost" methods such as fixing leaky faucets, repairing toilet valves, or educating building occupants about proper use of water-conserving equipment. Other options require more extensive retrofitting or replacement and may also fall under the category of "low cost/no cost."

This listing does not include every available water conservation option, and not all the options expressed in this chapter will necessarily conserve water at your installation. They are listed here merely for informational purposes to inform you of some of the many methods currently in use to conserve water. It is up to you, the Navy facility water manager, to determine which options are right for your facility, taking into account the information presented here, and factors relevant to your facility. For further information about water conserving devices and techniques, a list of recommended references is given in Appendix D.

It may be helpful when planning a water conservation program to remember that methods to conserve water can be categorized in other ways besides low or high cost, or maintenance versus replacement.

Water conservation methods can also be categorized as "supply" versus "demand" management strategies. Supply management strategies are those that are independent of the water user and which can be centrally managed by the public works office. They improve water efficiency and reduce unaccounted-for-water losses in the distribution system. Examples of supply management strategies include distribution leak detection and repair, metering, pressure reduction, watershed management, and evaporation suppression. Demand management strategies reduce water use at the facility or building level by the implementation of devices and techniques which reduce water consumption by the end users. Most of the options presented in this chapter are considered demand strategies.

A broader way to categorize water conservation methods is utility-side measures versus facility-side measures. Along with implementing facility water conservation options, your water utility can assist you to save both water and money in many ways. Below are some services your utility may provide:

- Rebates for equipment retrofits or replacements.
- Information on water efficient equipment and landscaping.
- Assistance with water audits and surveys.

- Assistance for leak detection.
- Metering and metering data.
- Rate structures:
  - Tiered
  - Seasonal
  - Excess use
  - Goal-based
  - Time-of-day

Contact your water utility to determine what services they can provide for your facility.

Facility-side measures, covered here, are those implemented by you at your facility.

B. Office Facilities and Residential

The Energy Policy Act of 1992 contains strict water conservation limits for several newly-manufactured office and residential plumbing products. As of January 1, 1994, all new **toilets** must use no more than **1.6 gpf** (gallons per flush), all new **urinals** no more than **1.0 gpf**, and new **shower heads and faucets** no more than **2.5 gpm** (gallons per minute). Figure 4-1 shows a comparison of water usage rates of these conserving devices and their traditional counterparts. Notice the dramatic difference between plumbing devices manufactured after 1994.

Traditional and conserving toilets, urinals, showerheads, and faucets, as well as other water consuming products found inside office and residential facilities are discussed below. Refer to Figure 4-2 as you read and note the potential water savings realized from implementing some of the presented options.

1. Toilets

Conventional and New: Toilets account for approximately 45% of indoor water use (Figure 1-6), making them a prime candidate for water conservation measures. The most common types of toilets are the gravity flow toilet, flush valve toilet, and pressurized tank system.

Gravity toilets work by using a tank of water and a rubber stopper. The water is released by the stopper and enters or "flushes" into the bowl from the tank by gravitational force.

Flush valve toilets have no tanks. Instead, pressurized water pipes are activated by valves to release water at specific flow rates into the bowl. Typically, gravity flow toilets are seen in residential buildings, and flush valve toilets in office/administrative buildings.

Pressurized tank toilets are a newer design of the old tank toilet and are made to use 1.6 gpf. Here, an air bag in the tank exerts pressure on the water to force it down into the bowl at great force. "Blowdown" toilets are pressurized tank toilets with the tank hidden behind the wall.

Traditional toilets (manufactured before 1980) are primarily gravity flow or flush valve and use 5 to 7 gpf. Since 1980, low flow toilets using 3.5 gpf, and ultra low flow (ULF) toilets using 1.6 gpf have been introduced into the marketplace. Un-

Figure 4-1: Water Usage Rates of Bathroom Plumbing Fixtures

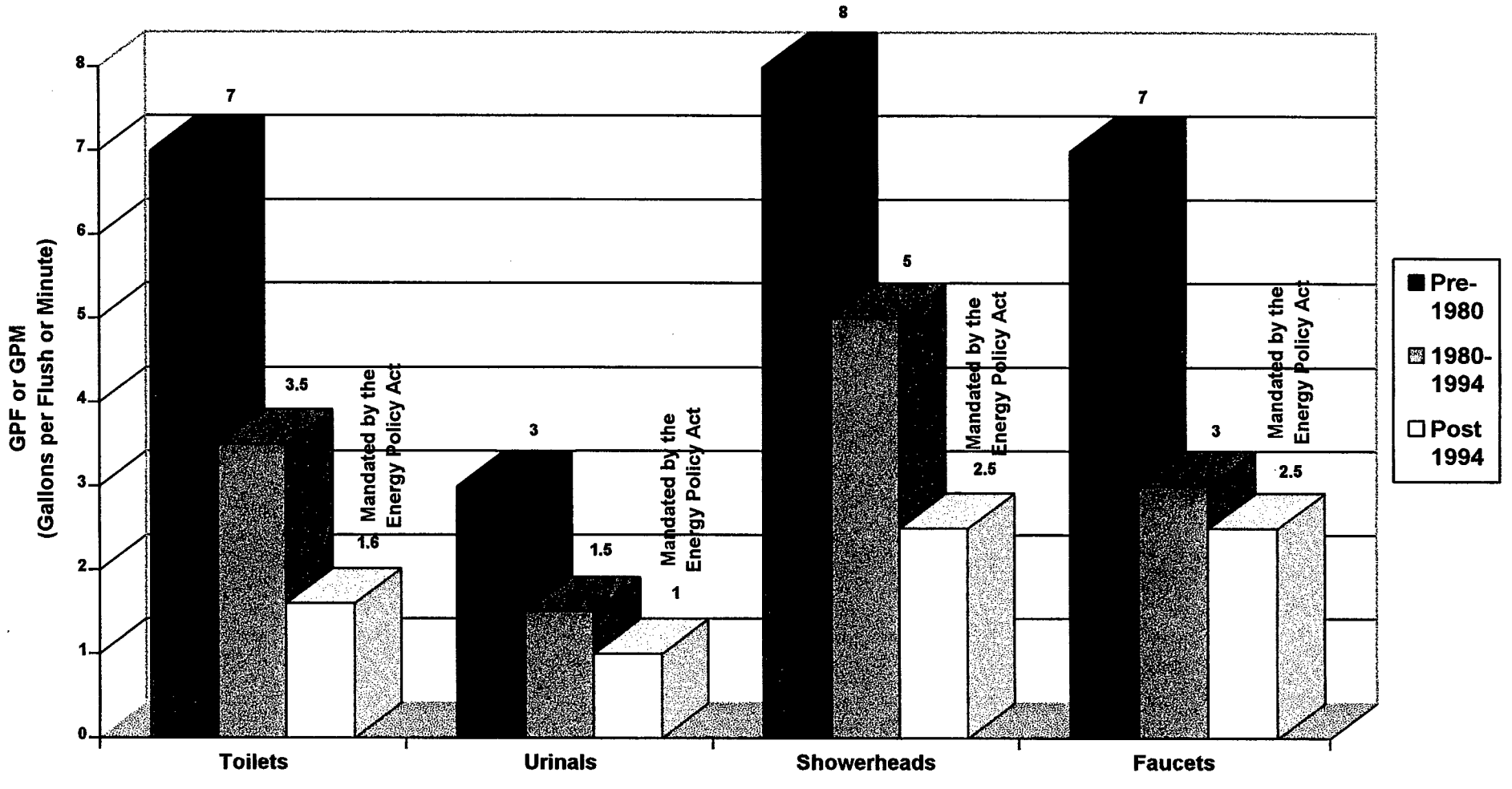


Figure 4-2: Potential Water Savings for Various Plumbing Fixtures

Device	*Average Flow Rate*	*Potential Consumption Savings (gpcd)*
Traditional Toilet	3.5-7.0 gpf	-
Ultra-low Flow Toilet	1.5 gpf	8-22
Traditional Urinal	1.5-3.0 gpf	-
Ultra-low Flow Urinal	1 gpf	1.5-4.0
Toilet Displacement Device	Varies	2**
Toilet Damming Device	Varies	4**
Traditional Showerhead	3.0-8.0 gpm	-
Low Flow Showerhead	2.5 gpm	4.3-8.1
Showerhead Restrictor Device	Varies	3.7**
Traditional Faucet	3.0-7.0 gpm	-
Low Flow Faucet	2.5 gpm	1.2-6.4
Faucet Aerator	Varies	0.5**
Traditional Dishwasher	9-12 gpc	-
Low Flow Dishwasher	5-9 gpc	1.0**
Traditional Clothes Washer	35-55 gpc	-
Low-Flow Clothes Washer	20-30 gpc	1.7**

From Water Efficiency, RMI, 1991.

Toilets: Assume four flushes per day per person
Showerheads: Assume 4.8 min/day shower per person
Faucets: Assume 4 min/day running faucet per person

** From Water Conservation, AWWA, 1987.

less your facilities have been renovated or newly built since 1980, it is likely that you are currently using traditional high-flow toilets, and wasting significant amounts of water. Replacing a conventional toilet with a 1.6 gpf toilet can reduce toilet water usage by as much as 70% per day!

Although not as effective as replacing a conventional toilet with an ULF, operation and maintenance procedures and retrofitting can reduce the amount of water your existing toilets use and make them more efficient. Keep in mind, however, that some retrofits may require frequent adjustment or maintenance and may interfere with the proper operation of the toilet, which was not designed to work with low volumes of water. Below are suggestions for maintenance and retrofitting:

Operation and Maintenance Procedures:

- Check and repair leaks. This is an important procedure! Huge amounts of water are wasted from leaky toilets and faucets. (See Figure 4-3)
- Replace worn parts if practical (e.g., valves, ballcocks).
- Adjust valves to more efficiently control water flow.

Retrofits:

- Displacement devices for gravity flow toilets - bags or bottles of heavy material which displace water in the tank, resulting in less water entering the bowl during or after each flush.
- Damming devices for gravity flow toilets - flexible inserts which partition the tank and prevent some of the water from leaving the tank during a flush, resulting in less water entering the bowl.
- Early-closure devices - restrictors at the flush valve, or new reduced-flow flush valves which save water by causing the valve to close early, reducing the amount of water used for flushing.
- Automatic sensors - infrared or ultrasonic devices which activate a flush after detecting the motion of an individual rising from the toilet seat.
- Weighted flappers - cause the flush handle to release early to shorten the flush duration, thereby saving water.
- Dual-flush devices - dual flush handles that allow a minimal flush by moving the handle one way and a maximum flush by moving the handle the other way.

Replacements: New gravity flush, flush valve, and pressurized-tank toilets are now designed and manufactured to meet or exceed the Federal requirement of 1.6 gpf. Variations of these designs include shallow trap toilets and compressed air toilets, and are available from many vendors. These toilets can be designed to look like traditional toilets.

Exotic waterless toilets are also commercially available, although not

Figure 4-3: Water Lost Through Leaks

Intensity	Amount of Water Lost gpd
	Faucet Drips and Leaks
Slow	36
Steady	180
One quarter open	664
One-half open	1620
Full open	3600
	Toilet Leaks
Seeping	30+
Constantly Running	6000

Note: gpd = gallons per day

nearly as common as the three types above. They are more costly to obtain and maintain, and are generally used in areas where water is scarce. Oil, composting, or incineration are some of the methods by which these toilets eliminate waste.

Problems and Pitfalls: As stated above, certain retrofits may adversely affect the performance of some toilets and may require frequent adjustment or repair. For example, take care not to choose displacement devices that eventually will crumble apart in the tank, such as bricks. Some retrofits are also expensive and time consuming to install (e.g., dual-flush devices). You should be aware of and prepared for these possibilities if you decide to retrofit.

Concerning replacement, ULF toilets are not all alike. Some brands outperform others. ULF toilets may require more frequent cleaning, some may not flush waste as efficiently as others, resulting in more flushes per use, and some may not provide sufficient "scour" velocity to the sewage lines to carry away the waste, resulting in increased sewage maintenance.

Overall, however, the most recent ULF toilets are more technologically advanced than the first ones to appear on the market a decade ago. With a little product research, quality ULF toilets can be obtained which have no more operating problems than conventional toilets.

2. Urinals

Conventional and New: Conventional urinals use 1.5 to 3.0 gpf. New urinals in compliance with federal regulations consume a maximum of 1.0 gpf. Savings of 1.5 to 4 gallons per day per person can be realized by using ULF urinals. Urinals come in a variety of designs and may be floor- or wall-mounted.

Siphon jet urinals are the most common type of urinal. They use a tank and a siphon device which discharges the flush tank when the water level in the tank reaches a certain height. There is no user-controlled flushing mechanism. Siphon jet urinals are appropriate for high traffic lavatories.

Washdown/washout urinals use a mechanical flush handle or button (user controlled) to activate the water to wash down the basin, carrying the liquid waste with it. These urinals are generally used in low traffic lavatories.

Blowout urinals work in a similar way to siphon jet urinals, except that the tanks are concealed behind the wall.

Listed below are some maintenance procedures and retrofits which will conserve water in conventional urinals.

Operation and Maintenance Procedures:

- Perform leak checks and repair as needed.
- Replace small parts, if practical to do so. Siphon jet urinals, for example, use rubber

diaphragms which should be replaced periodically.

Retrofits:

- Flushometer valves - fit conventional urinals with water-reducing parts.
- Timers - install on urinals that have constant water flow to turn the water off during no-occupancy hours.
- Sensors - install to automatically flush after urinal is used, preventing the user from over-flushing.

Replacements: The 1.0 gpf urinals come in the types listed above and are available from a multitude of vendors.

In addition to ULF urinals, there are waterless urinals. Waterless urinals work by using special trap inserts containing a biodegradable liquid. The liquid has a lower specific gravity than urine and floats on the surface of the trap as the heavier urine passes through to the sewer line. This prevents odors from permeating to the air above. Also, the urinal bowl is usually coated with a water and urine repellent material which prevents bacterial growth and odors. The trap is removed and replaced periodically. Manufacturers' claims indicate that the waterless urinals have substantially lower operating costs than flush type urinals, as well as increased water and sewage savings. If you are replacing or adding urinals at your facility, the waterless urinals, which look essentially the same as conventional urinals may be an appropriate choice.

Problems and Pitfalls: Fewer difficulties should result from retrofitting or replacing urinals than from toilets because of the less complex nature of the waste. However, you should monitor the updated urinals to make sure the waste is being sufficiently flushed, and that users are not throwing foreign matter such as cigarettes or paper into the bowls.

3. Showerheads

Conventional and New: Although showerheads are found mainly in residential housing units, many bases have showers in employee/resident recreational facilities as well. Conventional obsolete showerheads typically use 5-6 gpm at 80 psi when new. As they age, the flow rate may decrease to 3-4 gpm due to corrosion and hard water deposits.

New low-flow showerheads use 2.5 gpm or less at the same pressure. Installing these high-efficiency showerheads can result in savings of approximately 10-25 gallons per ten-minute shower, plus energy savings due to less demand for hot water. High-efficiency showerheads are relatively inexpensive, costing anywhere from $5-100. They are also simple to install. Many good models are under $50 and bulk-buying can greatly reduce the unit price.

Operation and Maintenance Procedures: The following procedures may be applied to high-efficiency showerheads as well as conventional ones.

- Check and repair leaks.
- Encourage shorter showers.
- Lower water heater temperature.

Retrofits: Although not nearly as effective as replacement, retrofits can be used on the existing showerheads if funds are not available to replace them with high-efficiency units.

- Restrictors - special washer device with a center hole that reduces water flow when placed inside the showerhead.
- Pressure reduction valves - reduces the water pressure to the shower which reduces the amount of water flow.
- Shut-off valves - similar to those used on Naval ships where water supplies are very limited. It allows the user to turn the water off while soaping up, then on again when rinsing. These can be used with high-efficiency showerheads as well.

Replacements: Many brands of high-efficiency, low-flow showerheads are commercially available and come in many shapes and sizes.

There are three basic designs by which these heads deliver water. "Aerating" showerheads work by drawing air into the flow of water, producing fine water droplets over a larger surface area. "Atomizer" heads mist the water and deliver it in extremely fine droplets over a large surface area. "Pulsating" heads cause the water to be delivered in pulses alternating between high flow and mist. Some showerheads have adjustable flows which can change the water delivery from pulsating to mist. In any case, the latest technology allows high-efficiency showerheads to provide as "satisfying" a shower as the conventional types while still conserving water.

Consider, also, installing the showerhead as a hand held unit instead of a fixed-in-place model. Shower users may decrease their amount of shower time with a hand held head because of the ability to precisely direct the spray, thereby reducing rinse time. Hand held models, however, are at greater risk to be mishandled or vandalized.

Problems and Pitfalls: Restrictor retrofits often result in poor shower performance and are not recommended for long-term conservation. Shut-off valves may cause temperature differences in the water and could result in scalding when the water is reactivated.

The risk of scalding may also increase with low-flow showerheads if plumbing lines do not maintain proper water pressure while nearby toilets are flushed. Lowering the temperature at the water heater and installing anti-scald valves will help to remedy this. Alternatively, the plumbing itself could be replaced.

User satisfaction with a high-efficiency showerhead depends on how the shower "feels" in comparison to a shower with a conventional head. User satisfaction will gener-

ally be low if the chosen heads do not provide adequate wetting ability and perceived water pressure. Some field testing may be needed before a final choice is made as to the exact brand and model that will best suit your facility.

4. Faucets

Conventional and New: Conventional bathroom (and kitchen) faucets use 3-7 gpm. New faucets, designed to meet federal codes, use a maximum of 2.5 gpm at 80 psi, although most bathroom types are being manufactured to use 1.5 gpm or less. Assuming high-efficiency faucets are left on for the same amount of time as the conventional types, a savings of 1-6 gallons per person per day can be realized for each high-efficiency faucet used.

Operation and Maintenance Procedures:

- Faucets should be periodically checked for leaks and repaired as needed. Leaky faucets can waste enormous amounts of water (tens of gallons in a single day).
- For conventional faucets, water flow can be reduced by adjusting the flow valves if applicable.

Retrofits: The following retrofit options may help reduce the amount of water your conventional faucets use.

- Restrictors - same as for showerheads, they are washers with center holes which restrict the flow of the water through the faucet.
- Aerators - a device that uses a screen to mix air and water in the faucet head, giving the illusion that more water is flowing through the faucet.

Replacements: The new low-flow faucets come in a wide variety of aesthetic styles, but essentially operate in one of two ways: aeration or laminar flow. In laminar flow faucets, the water travels in parallel streams producing a clear flow of water without being mixed with air (as in aeration). This produces superior wetting ability over that of aerating faucets. Laminar flow faucets are more expensive than aerating types but not extravagantly so.

It is becoming an industry standard to add trickle shut-off valves or levers to faucets. These levers allow the user to shut off the water when performing some task which does not require it, then to turn the water back on at the exact same flow and temperature. The valve prevents the need to turn the faucet off or to readjust the flow and temperature.

Some low-flow faucets are metered-valve type, meaning they will deliver a fixed quantity of water and then shut off automatically. Other types of "automatic" faucets include self-closing and sensored. Self-closing faucets work with a spring-loaded lever which slowly returns to its original position and turns off the water. Sensored faucets, either infrared or ultrasonic, are designed to turn on when a user's hands are

placed under the faucet, and turn off when the hands are removed.

Problems and Pitfalls: Faucet aerators need to be checked periodically for clogging, some models clog more easily than others and may need to be cleaned too often to be effective. Some aerators may cause unacceptable performance or the perception of poor performance, resulting in an increase in water use.

The levers or handles which control the faucets on non-sensoring types may also make a difference. Whereas sensored faucets are designed to deliver water at a set volume and temperature, single bar levers on nonsensored faucets tend to cause the user to use more water than necessary to achieve a desired volume and temperature. Redesigned levers can be purchased which will deliver only a set temperature or even just cold water unless deliberately pushed completely to the left for hot water. Two-handled faucets also precipitate the same problem. Foot-controlled levers for office lavatories may be an alternative to sensored devices and help to prevent the spread of germs. Sensored faucets are usually not appropriate for kitchens due to the need for total volume and temperature control by the user.

5. Chilled Drinking Fountains/Ice Machines

Ice machines and chilled drinking fountains are not currently covered under Federal regulations, therefore there are no specific conventional versus new comparisons to be made. However, with proper maintenance you can realize both energy and water savings for these units, whether stand-alone or centrally controlled systems. You might also choose to replace older units with newer, more energy efficient models.

Operation and Maintenance Procedures: Existing drinking fountains can be made to operate more efficiently by implementing the following suggestions:

- Provide adequate insulation around the chiller unit and any exposed pipes.
- Set the chillers' temperature controls to slightly higher temperatures. The water does not need to be ice cold to be satisfying.

Existing ice machines can be made to operate more efficiently by implementing the following:

- If possible, locate the ice machine indoors in a relatively cool spot. Placing the unit in a hot location, such as outdoors in a warm climate, will make the unit work harder and use more energy and water to produce ice.

Retrofits:

- Install timers on drinking fountain units to turn the chillers off during no-occupancy hours.
- Water-cooled ice makers can be retrofitted to be cooled by the facility's chilled water system, if one exists.

Replacements: Water-cooled ice makers can be replaced by air-cooled condenser units. Air-cooled condensers do not require any water for cooling. Also, consider replacing a cube machine with an ice flake machine. Machines that flake the ice instead of cube it do not need bleed-off water to carry away visual contaminants from the cubes.

6. Washing Machines

Conventional and New: Current washing machines in family housing units are primarily top-loading, vertical-axis machines which use 35-55 gpl (gallons per load). Laundromat type washers are front-loading, horizontal-axis machines. These commercial style washers typically use only 25-30 gpl, due to the fact that they tumble the clothes on a horizontal axis enabling them to use less water. A third type of washer is a top-loading, horizontal-axis machine which combines the convenience of the top loader with the water efficiency of a horizontal-axis machine.

Operation and Maintenance Procedures: For existing washing machines, the following suggestions will aid in conserving water:

- Check and repair leaks.
- Encourage users to wash only full loads.
- If water level is able to be set by the user, encourage using only as much water as needed for that load.
- Use quality detergents with enzyme action to more effectively clean the clothes in the lower temperature water.

Retrofits: The only retrofit which can be applied to washing machines is a rinsewater recycling system (see Recycling and Reclamation under the section "Industrial Laundries" later in this chapter). Generally, this will be applied to base laundromats and industrial laundries, rather than residential homes.

Replacements: The water efficient washing machine has not advanced as far as other water conserving devices (e.g., toilets). There are not many manufacturers of household front-loading, horizontal-axis washers, and currently, top-loading horizontal washers for home use are only available in Europe. The household front-loader is slightly more expensive than the conventional top-loading, vertical-axis model, but not significantly so. Older washers can also be replaced with newer ones which have more options for controlling water levels and temperature.

Problems and Pitfalls: As mentioned above, the cost of the water-efficient front-loading washers is slightly more than that for the conventional type. Also, the conventional top-loading washers hold 50% more laundry than the front-loading types. A cost analysis must be performed for your residential facilities to determine if replacing top-loaders with front-loaders will result in significant water savings and outweigh the increased number of required loads.

7. Dishwashers

Conventional and New: Dishwashers can be classified as residential or commercial. The familiar rack type dishwashers are used in residential households. Commercial type dishwashers are used in cafeteria or restaurant facilities.

Commercial dishwashers or "warewashers" are available in a variety of rack and conveyer designs. They are either high temperature-rinse or low temperature-rinse machines, meaning they rinse and sanitize the dishes with either 180°F or 140°F water, respectively. In conveyor dishwashers, the dishes are placed in a tray on a conveyer and passed into the warewasher after manual pre-rinsing. Warewashers use approximately 1-1.5 gpm, depending on design and features. Conventional older rack washers use between 9 and 12 gpc (gallons per cycle). Most new residential dishwashers currently sold use between 5 and 9 gpc. They incorporate a variety of features that allow them to conserve water, but which are primarily included to conserve energy.

Below are suggestions for maintaining or retrofitting your existing dishwashers, and also a discussion on the options available in new models.

Operation and Maintenance Procedures: The following are water saving procedures to implement with existing dishwashers:

- Check and repair leaks in hoses, spray rinse fixtures, etc.
- Wash only full loads in residential rack-type dishwashers.
- Use minimum flow rates suggested by the manufacturer.
- For conveyer types, reduce flow rates for the pre-wash spray, if present, to minimum acceptable levels.
- For conveyer types, ensure that the flow of water stops when no dishes are present.

Retrofits:

- Install pressure or flow regulators to limit flow to the manufacturer's suggested levels.
- Equip conveyer types with an "electric eye" to automatically shut off the water unless dishes are present.
- For conveyor types, limit or eliminate scrapping troughs (used to carry away food waste in a stream of water to the garbage disposal).

Replacements: New rack-type dishwashers include one or more features to aid in conserving energy for compliance with DOE standards. Many of these energy-conserving features save water as well. The most common of these features is the booster water heater which internally heats the incoming water to at least 140°F. This allows the water heater to be turned down to 120°F for other household demands. Another feature is an improved spray arm geometry. Developed in Europe, the alternate spray system allows water to be sprayed alternately through the top and bottom spray arms, instead of both at once.

Less water is used even though the wash quality remains the same. Other features include an improved sump fill control which makes use of timers to control the volume of water initially admitted to the dishwasher, and an improved sump geometry that protects the pump (from drawing in air) with a smaller volume of water. Additionally, improved food filters and more efficient motors permit enhanced cleaning power with less water.

Newer commercial warewashers also make use of the booster heater. Moreover, since a significant amount of water is used in the prerinse phase of commercial dishwashing, manufacturers are developing methods and equipment to reduce the amount of water used for this stage. One of these methods is called ultrasonic prerinse. As the name implies, the rack of dishes is immersed in a large tank of hot water with detergent and ultrasonically cleaned (with sound waves) for a specified period of time. Food residue is loosened from the dishes which are raised out of the tank, drained, and sent on to the warewasher. Less water is consumed and the food residue is filtered and dumped into the trash instead of being rinsed into the garbage disposal.

Problems and Pitfalls: Today's dishwashers are geared primarily towards saving energy. Research on the many different brands and styles is needed to select one which is also highly water efficient. Some models are better than others.

Concerning commercial warewashers, the low-temperature-rinse units may use less energy but require more water and wash fewer racks per hour than the high-temperature-rinse units. They also use more detergent. Some models do not have internal heaters to ensure that the water temperature does reach 140°F, so the water used may be even cooler than this, depending on the temperature of the incoming water or how long the water sits in the fill tank. Lower water temperatures may lead to less effective rinsing and increased residue on the dishes. This is an important factor in commercial applications where the cleanliness of the dishes is most critical. Gas booster heaters (rather than electric ones) allow high-temperature-rinse warewashers to still be energy efficient while (more) effectively cleaning the dishes with less water than a low-temperature-rinse washer.

8. Garbage Disposals

Although newer technology has improved the disposal's waste grinding ability, the garbage disposal's use of water is primarily dependent on the user. Since it is not absolutely necessary to dispose of food waste down the sewer, you may want to consider eliminating garbage disposals in new construction at your facility. This could, however, create dissatisfaction and plumbing problems, as occupants/users may dislike the inconvenience of not having a garbage disposal and may attempt to use the sink as a food dump anyway.

For existing garbage disposals, public education is the key. Encourage users to utilize the garbage disposal sparingly, and to use only the minimum amount of water necessary to flush the food waste down the sewer. Discourage using the garbage disposal for inappropriate items such as bones, fat gristle, nut shells, etc.

9. Water Softeners

Water softeners are generally used for hot water applications such as boiler feedwater and bathing. Water softeners are another appliance in which the water use primarily depends on the operator. Consider eliminating water softeners where not needed, e.g., geographical areas where the tap water is not excessively hard, and for applications such as drinking, landscaping, and toilet flushing.

Operation and Maintenance Procedures:

- Set the softener controls to start the softening/ regeneration process only when needed.
- Check and repair leaks in plumbing connections.

Replacements:

- New softener models may come with water-efficient regeneration cycles.
- Some water softeners are available which are removed by the vendor for off-base regeneration, eliminating this water-consuming step on-base.

Problems and Pitfalls: Water softeners create calcium sludge when softening hard water, which may adversely affect the outgoing sewer line. Check that your softener units are only running when necessary to reduce the amount of sludge. Using a higher quality softener salt may also help.

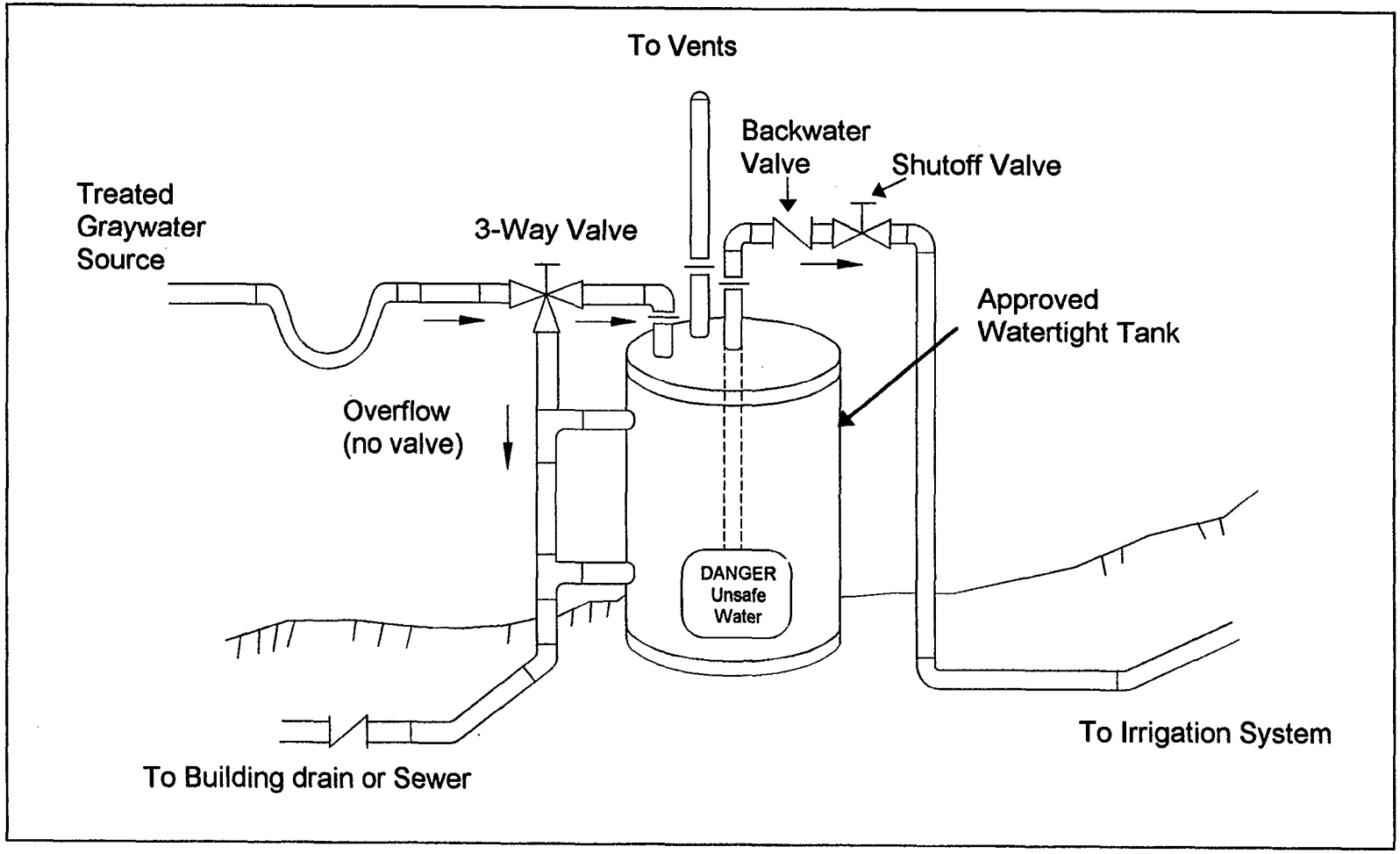
10. Water Recycling and Reuse in Office and Residential Facilities

In addition to implementing the water conserving devices discussed in the previous sections, it is also possible for you to conserve water at your base by recycling the water used in offices and residential facilities to other applications. Common uses of recycled wastewater include: irrigation, toilet and urinal flush water, and cooling tower make-up water.

There are two types of wastewater generated from offices and residential facilities: graywater and blackwater. Graywater is water discharged from bathroom sinks, showers, and washing machines. It generally contains dirt and soap or detergents. Blackwater refers to water used to flush waste from toilets, urinals, dishwashers, and kitchen sinks. It contains food or human waste.

Both graywater and blackwater require some level of treatment before they can be recycled. Graywater is generally filtered and, if needed, treated biologically or chemically to remove any dangerous disease-

Figure 4-4: Typical Graywater Piping and Distribution System.



Source: Proposed Code Change to a Section and/or Sections of the UPC-USPC-USEC, Submitted to the National Association of Plumbing and Mechanical Officials, Los Angeles, CA, February 1992.

causing microorganisms. It may also require treatment to reduce the levels of cleaners present. Graywater is most commonly used in irrigation, where potable-grade water is not required and the treatment requirements are less demanding. Figure 4-4 shows a design for a graywater distribution system for irrigation use. Blackwater obviously requires much more extensive treatment and may involve a number of processes. The cost of implementing such a system on-base can reach hundreds of thousands of dollars. Also, there are regulations regarding the performance of such systems which must be followed to ensure that public health is not endangered. Figure 4-5 shows a wastewater treatment and recycling system for a commercial building.

For established facilities with plumbing already in place, implementing an on-site wastewater treatment system will necessitate obtaining access to drain pipes and sewer lines and could involve extensive effort.

When considering if a wastewater treatment and recycling system may be appropriate for your facility, it will be helpful to answer or consider the following:

- How much wastewater does our facility generate?
- Which buildings do we want to consider for wastewater recycling?
- What will the water be recycled to?
- How much of it do we want to recycle?
- How extensive a treatment system do we need and want?
- Where will the system be built?
- What are the implementation costs? Should we lease or buy the system? (Consult with a number of vendors and manufacturers to find out what technologies are available).
- What will be the operational and maintenance costs?
- Will the ultimate savings from reduced water consumption and discharge costs outweigh the cost of the system?
- What is the payback period?

With careful planning, a wastewater recycling and treatment system can provide significant water savings and reduce the expense of purchasing and discharging facility water.

C. Industrial Operations

1. Washrack Cleaning Facilities

The Navy maintains nine categories of facilities for washing and rinsing its aircraft and vehicles:

Aircraft Washrack Pavement

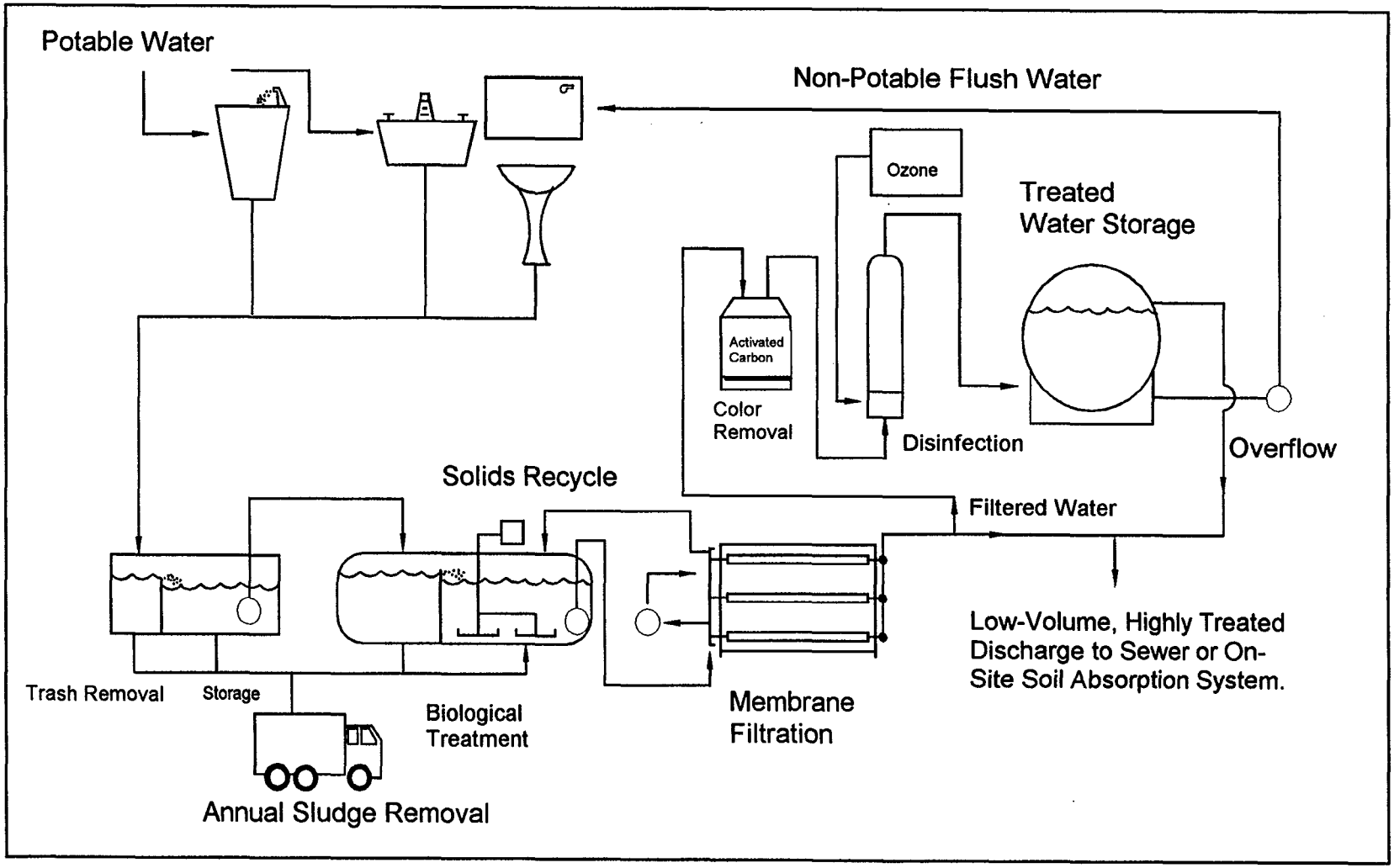
Aircraft Rinsing Facility

Aircraft Fire and Rescue Station

Combined Structural/Aircraft Fire and Rescue Station

Landing Craft Washrack

Figure 4-5: Combined Wastewater Treatment and Recycling System for a Commercial and Industrial Building.



Source: Thetford Corporation (Cycle-Let model).

Amphibian Vehicle Maintenance Shop

Combat Vehicle Maintenance Shop

Automotive Vehicle Maintenance Shop

Vehicle Washing Platform

Over 1200 washrack facilities encompass aircraft, automobiles, and track vehicles (such as tanks). With so many facilities using large amounts of water on a regular basis, they are an excellent candidate for water conservation.

Conventional and New: The categories of wash facilities can be grouped according to the type of wastewater emitted from each. Figure 4-6 shows the five groups with corresponding water requirements, typical wastewater quantities, and effluent chemical make-up. Newer, commercially available washrack equipment will usually include some of the retrofits and recycling options listed in the sections below. It is not feasible to give precise water or cost savings for implementing these options, since each facility is unique in its function, setup, and usage rates. It can be said, however, that from data collected from Army installations which have implemented these measures, water savings of up to 70-80% have been realized. The initial capital cost of installing a recycling system can range from approximately $20K to several hundred thousand, depending on the technology employed.

Operation and Maintenance Procedures:

- A periodic check of equipment for leaks or malfunctions is a simple but effective way to conserve washrack water.
- Using high quality detergents with superior cleaning power combined with good rinsability will shorten the length of time required to clean each vehicle or aircraft.

Retrofits: For existing wash facility equipment, there are several low cost measures which are capable of saving significant amounts of water.

- Timers - useful in aircraft rinsing facilities, but not for washrack units since each vehicle or aircraft must be washed until sufficiently clean. The timing is different for each run and should not be preset.
- Spray apparatus - automatic spray heads are recommended for aircraft rinsing, but not for washing, for the same reason listed above.
- Automatic shutoff spray nozzles - these devices are designed for facilities with manual rinsing. They are the same basic design as a garden spray nozzle. Considering that water is usually left on during the entire time a vehicle or aircraft is washed and rinsed, the automatic shutoff spray nozzle can save tens to hundreds of gallons per run.

Figure 4-6: Washrack Water Requirements

Type of Facility	Water Required per Item	Wastewater Produced
Aircraft Rinsing	1000-3000 gallons	1750 gallons (average)
Aircraft Washrack Platform	200 gal (helicopter) 2500-3000 gal (aircraft)	2000 gallons (average)
Automotive Vehicle Washrack	100-1000gallons depending on size	200-1000gallons (average)
Tracked Vehicle Washrack	1000-3000 gallons	2000 gallons
Automotive Vehicle Maintenance	same as automotive washrack	same as automotive washrack

Typical Effluent Contaminants:

Group 1 - Things removed from the aircraft/vehicle during washing include oils, dirt, grease, oxidized metal bits, salts, and paint.

Group 2 - Chemicals added to the water to clean the aircraft vehicle include detergents, emulsifiers, paint strippers, solvents, and corrosion inhibitors.

- Low flow/high pressure hot water units - can reduce the amount of water and solvents used by facilities for cleaning engine components. The standard method for cleaning engine parts has been to use organic solvents or low-pressure cold water. High-pressure hot water greatly reduces the required amount of water and solvents, which must be treated and disposed of as hazardous waste.
- Prewash areas - for tracked vehicle washracks with recycling systems, to eliminate a majority of the coarse dirt so that it will not enter into and clog up the treatment system.

Water recycling and reuse: The costliest, but highly effective way to reduce water consumption at wash/rinse facilities is to implement a wastewater recycling system. The type of wastewater treatment system you choose will depend on the configuration of your facility. Figure 4-7 shows possible water reclamation systems for two common types of automatic vehicle washracks: tunnel (gas station car washes) and rollover. Passing through these systems, treated wastewater is recycled back to the washrack for reuse.

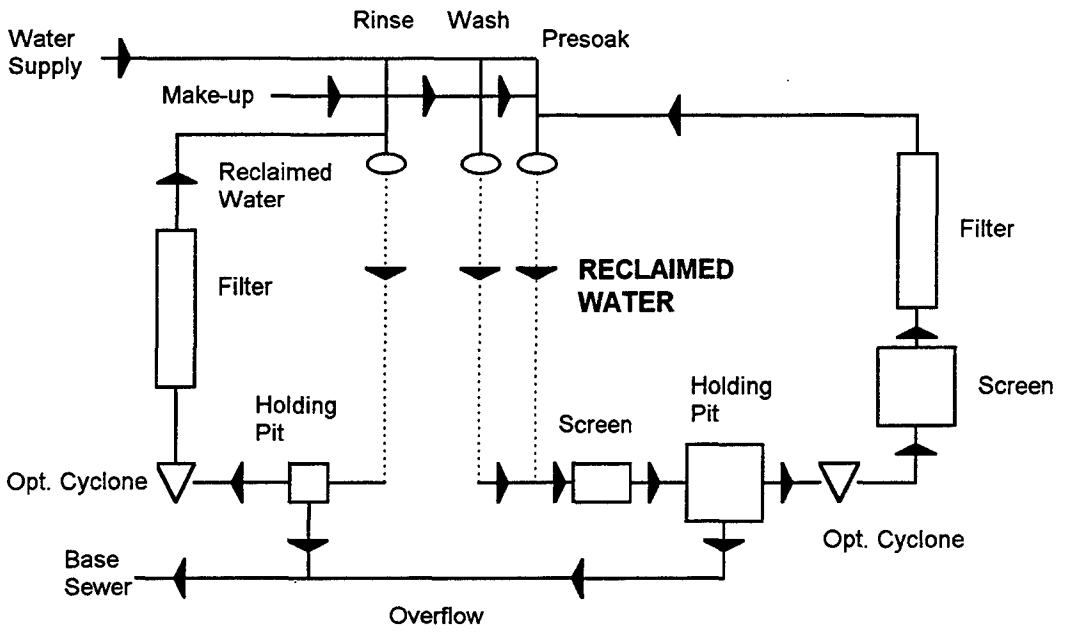
Remember, the treatment system must be capable of providing water with acceptable quality before it can be reused. The reclaimed water's quality depends on what system components are used and what the incoming water consists of. Figure 4-8 shows the acceptable levels of contaminants for water supplied to vehicle washrack facilities. Wastewater treatment systems are likely to contain the following components: sand traps, oil and water separators, screen filters, coarse/polishing filters, and storage tanks for the treated water.

Water reuse from or to other industrial applications is another alternative. Vehicle washrack effluent may be directly used in metal cleaning and painting applications, depending on its quality, for preliminary or intermediate cleaning and rinsing stages. Water discharged from cooling tower bleed-off or boiler blowdown may be used for washracks after minimal treatment. Treated sewage effluent may also be used but only with proper treatment and should only be used for presoaking or first-wash stages.

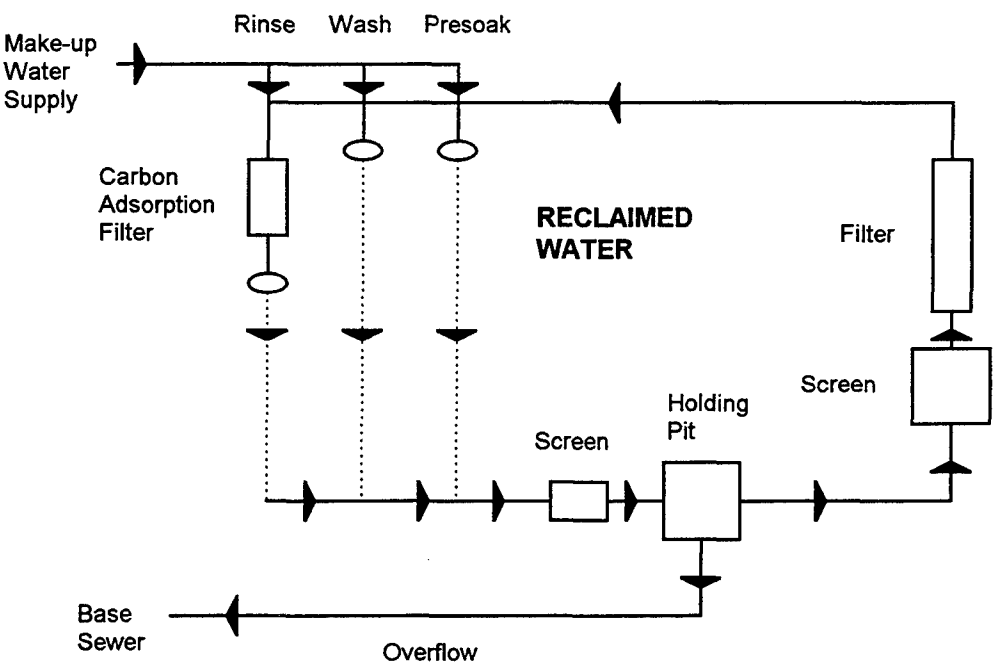
To determine what retrofit or recycling options are suitable for your facility, you need to collect field data and perform a cost analysis. You should obtain the following information:

1) Daily water usage for each facility (use flowmeters to calculate the flow volume).
2) Types of equipment used.
3) Manpower and time required for each wash/rinse.
4) The number of vehicles or aircraft washed daily.
5) The quality of your effluent water.

Figure 4-7: Two Types of Washrack Water Reclamation Systems



A. Separate Rinse Water Reclamation from Rinse Cycle, Used in Tunnel Type of Washracks



B. Combined Wash and Rinse Cycles, Commonly Used in Rollover Types of Washracks

Figure 4-8: Tolerable Water Contamination Levels

Constituent	Vehicle Washracks Concentration (mg/L) *	Metal Finishing Concentratio (mg/L) *	Metal Cleaning w/Hot & Cold Rins Concentration (mg/L) *	Paint Stripping Concentration (mg/L) *
Ammonium (NH4)	15	0.5	0.5	15
Arsenic (As)	N/A	0.05	0.05	N/A
Biochemical Oxygen Demand (BOD) 5	20	1	1	20
Boron (B)	**	1	1	**
Cadmium (Cd)	N/A	0.01	0.01	N/A
Chromium (Cr)	N/A	0.05	0.05	N/A
Chlorine (Cl)	300	N/A	N/A	600
Chemical Oxygen Demand (COD)	100	3	3	50
Copper (Cu)	N/A	1	1	N/A
Cyanide (CN)	0.5	0.2	0.2	0.5
Hardness (CaCO3)	N/A	10	10	500
Hydrogen Carbonate (HCO3)	N/A	5	5	N/A
Iron (Fe)	40	0.3	0.3	40
Lead (Pb)	N/A	0.05	0.05	N/A
Manganese (Mn)	N/A	0.05	0.05	N/A
Median Coliform #	N/A	N/A	N/A	< or = 2.2/100 ml
Nitrate (NO3)	**	10	10	**
Oil & Grease	5	N/A	5	5
Phenol	3	0.001	0.001	3
Phosphate (PO4)	**	N/A	N/A	**
Sodium (Na)	300	N/A	N/A	600
Sulfate (SO4)	N/A	5	5	N/A
Suspended Solids	60	1	1	20
Total Alkalinity (CaCO3)	300	N/A	N/A	N/A
Total Dissolved Solids (TDS)	1000	250	250	2000
Zinc (Zn)	N/A	5	5	N/A

* All Concentrations Estimated
** Concentrations NOT significant
N/A = Not Applicable
mg/L = milligram per Liter

2. Plating Facilities

The Navy operates a number of plating facilities which encompass a variety of processes, including hard chrome plating, nickel, zinc, or cadmium plating, etching, and phosphating. Plating is a general term describing the practice of applying a surface coating to a metal or nonmetallic item to impart corrosion resistance, wear resistance, or for decoration. The process of plating involves several steps, including surface preparation, plating, and post-treatment. All of these steps incorporate rinsing procedures to rid the part of residues from the previous step. Rinsing uses a majority of the water utilized in plating operations and is therefore the prime target for water conservation.

Conventional and New: Conventional plating facilities are those which do not incorporate the retrofit or recycling options discussed below. Typical features of a traditional, water-wasting facility include continuous overflow rinse tanks, contaminated plate bath solutions which are discharged instead of repurified, lack of drip trays or splash guards, short drip times resulting in excessive drag-out of bath contaminants, and overcrowded racks.

As for washrack facilities, it is difficult to predict what the exact water and cost savings will be for your particular facility when you implement the described water conservation measures. However, from the data collected at facilities that have implemented these measures, water savings of approximately 50-90% have been realized. Using a water recycling and reclamation system also greatly reduces sewage and hazardous waste costs, which can be significant for large-scale plating shops.

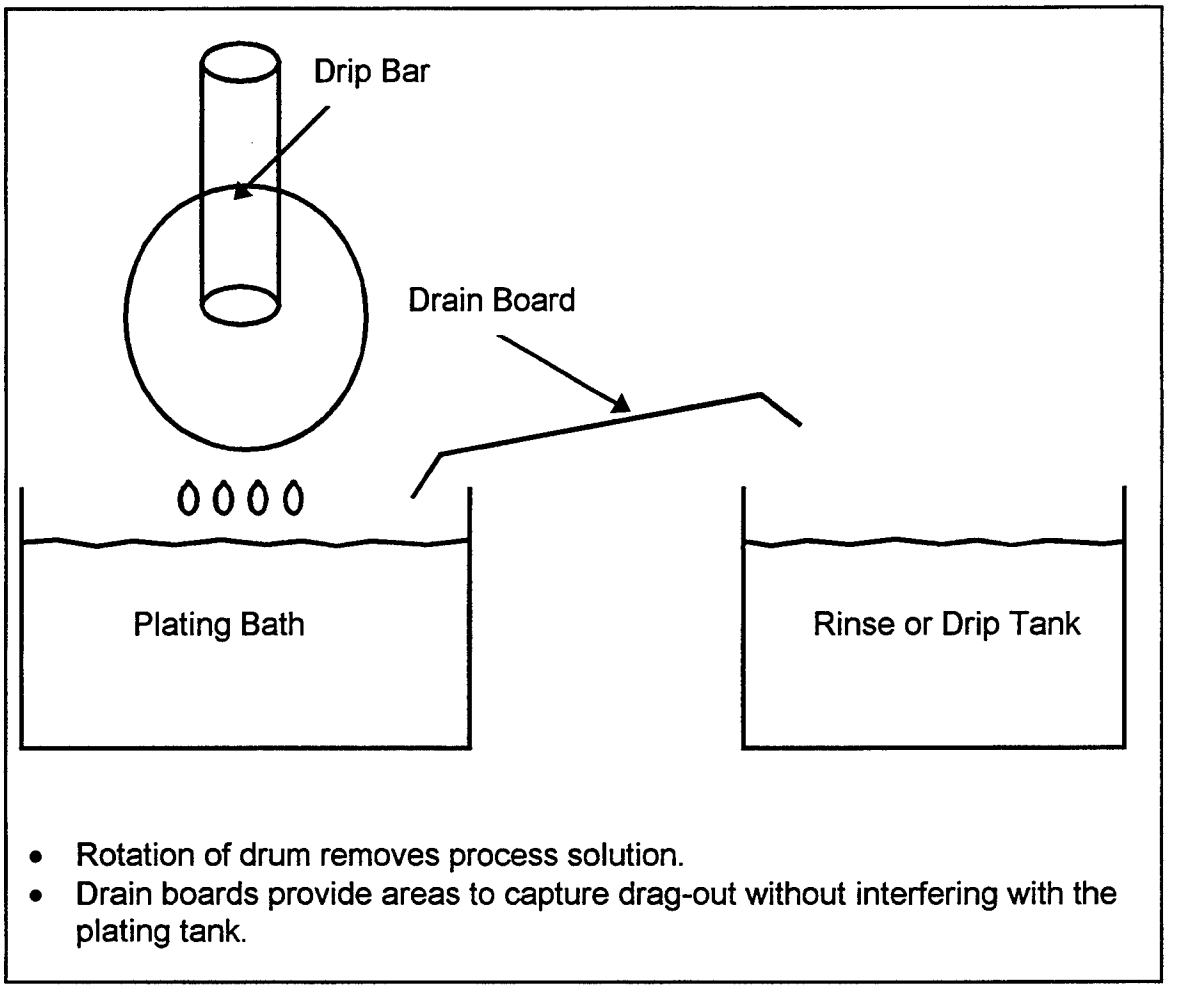
Operation and Maintenance Procedures: The following are simple, low cost procedures which can save significant amounts of water:

- Check and repair leaks.
- Do not overcrowd parts on the racks.
- Orient parts on the rack so they are tilted or tipped to allow proper drainage of planar surfaces, and to reduce the surface area of the part which contacts the bath solution last.
- Cover bath tanks when not in use.
- Lengthen drip time to reduce drag-out of bath contaminants.
- Avoid flooding with water as a clean-up method.
- Shut off water flow to rinse tanks when not in use.

Retrofits: The following are retrofit alternatives which are low to moderate in cost:

- Flow restrictors or control systems - restrictors for manual control and controller systems for automation of the flow of freshwater into the rinse tanks.
- Conductivity controllers - devices used to measure the total dissolved solids in the

Figure 4-9: Drain Board and Drip Bar



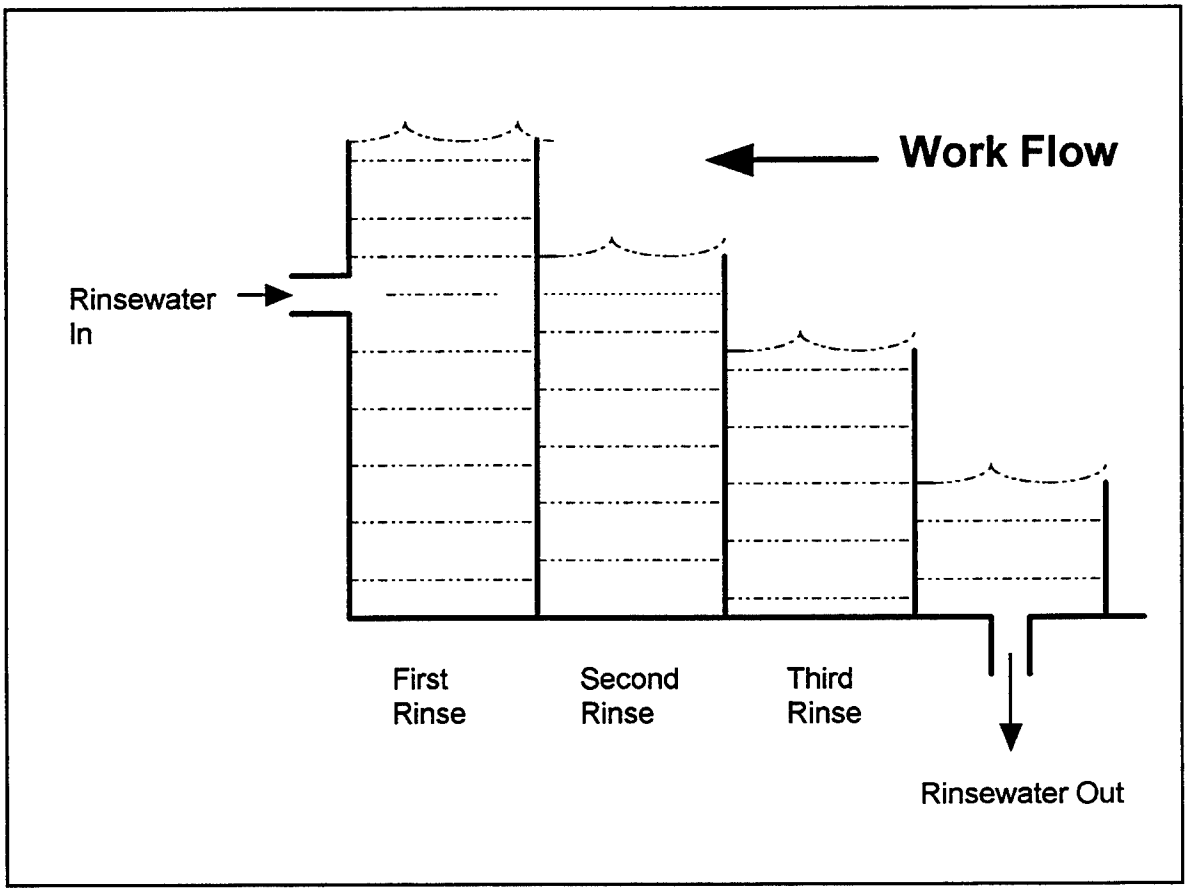
- Rotation of drum removes process solution.
- Drain boards provide areas to capture drag-out without interfering with the plating tank.

rinse water and automatically adjust flow control valves.

- Drip trays (or bars) and drain boards - devices which reduce drag-out during transportation of an item between the plating and rinse tanks by collecting the lost solution and returning it to the plate bath. Figure 4-9 illustrates such devices.
- Splash guards - devices which reduce spillage of bath or tank solutions caused by movement of the item in and out of the tank.
- Wetting agents - cause plating solutions to more easily flow over and attach evenly to the surfaces of the workpiece. This reduces drag-out.
- Automatic nozzles - for use on continuous flow rinse tanks, these devices allow the operator to shut off the water when not needed, eliminating continuous water flow.
- Timers - allow the feedwater to the rinse tanks to be automatically shut off when fresh feedwater is not required.
- Air knives - devices which work by using air streams to blow off excess solution from the plated parts. The excess solution then drops back into the tank, reducing drag-out.
- Spray rinses - several spray heads are mounted in a tank chamber and either manually or automatically controlled to rinse the workpiece as it is drawn out of the tank. Spray rinsing is not recommended for parts with many sides or small crevices, as the spray will not reach these areas as effectively as a dip rinse.
- Static tanks - use more than one rinse tank, making the first one a "static" tank. That is, do not use a continuous overflow tank which is continuously diluted with fresh incoming water. Most of the drag-out from the plated piece can be rinsed into the static tank, leaving the next rinse tanks cleaner longer. The static tank can be refilled as needed, and when concentrated may be recycled or disposed of as waste.
- Multiple countercurrent rinse systems - employ several tanks which all use the same freshwater feed. The plated parts are successively rinsed in tanks with increasingly clean water. The water flows in the opposite direction and exits out the first and dirtiest rinse tank. Figure 4-10 shows a three-stage countercurrent rinse system.

Recycling: The procedures and retrofits described above will significantly reduce the amount of water used in rinsing processes. To avoid wastewater discharge altogether (zero discharge), or to at least minimize it, the implementation of a recycling/reclamation system is recommended. The term "recycling" will be used here to mean reusing the water with little or no treatment. The term "reclamation" will be used to refer to treatment then reuse of the water in the plating facility itself (as

Figure 4-10: Counter Current Rinsing



opposed to reuse as irrigation water, for example).

One type of recycling system which recycles the rinsewater one or more times then discharges it is called "reactive rinsing". It is less expensive than countercurrent rinsing since it does not require extra tanks. Reactive rinsing can be implemented in one of two ways: intraprocess or interprocess.

"Intraprocess" reactive rinsing can be used for a single plating process which employs several different baths and several rinse tanks to rinse away each solution. Instead of using fresh water for each rinse tank, the discharge from one tank is used as the rinsewater in another tank, if appropriate (meaning the chemicals will not harm the second tank rinse). Thus, the water is reused in the plating process before being discharged.

"Interprocess" reactive rinsing can be used when there are more than one plating processes operating simultaneously. Instead of requiring a separate freshwater feed line for every rinse tank, rinsewaters from rinse tanks in one process are reused in the rinse tanks of another process.

Reclamation and Recovery of used rinsewater or plate bath solutions for use in the same processes requires a more costly and complex approach. There are several separation technologies available which are designed to recover plating metals, acids and other chemicals from the water, but not specifically to conserve the water. If reuse of the water itself is the focus, any treatment technique must be capable of producing recycled water that is suitable for reuse in either the rinse tank or plate bath. See Figure 4-8 for the approximate tolerable concentrations of chemical contaminants for a plating solution.

The major separation technologies include: ion exchange, reverse osmosis, evaporation, and diffusion dialysis or electrodialysis. Filtration should be used as a pretreatment for these methods to first remove undissolved, suspended impurities in the water.

Ion Exchange is the same method by which water softeners work. For plating rinsewaters, beds of "ion exchanging" resins retain ions (charged particles) of plating chemicals (metals) which have been dragged into the rinsewater from the plate bath solution, and exchange them (release into the water) with other ions harmless to the rinsewater's application. The retained metals in the resin are then extracted by regeneration. During regeneration, a strong acid or base is used to recover the plating ions by exchanging them for the original resin ions. Depending on the purity of the recovered metals, they can be added back into the plating solution. Ion exchange systems can be set up to regenerate automatically, but still require more operator attention and maintenance than other recovery technologies.

Reverse Osmosis uses membranes instead of resins to separate metal salts from rinsewater. Rinsewater is purified by forcing it through the membranes at high pressure, leaving behind the metals. Reverse osmosis membranes are sensitive to oxidizing chemicals and extremely low or high pH's, and are susceptible to fouling in concentrated or hard water solutions.

Evaporation simply involves boiling off water from the contaminated rinsewater, condensing the purified water vapors for reuse in the rinse tank, and returning the concentrated leftover metal solution to the plate bath. Evaporation requires thermal energy to operate and thus needs a rinsewater solution of sufficient original plating metal concentration to be cost-effective.

Diffusion Dialysis or Electrodialysis are more recently developed methods than the technologies listed above, and their effectiveness is still being researched and refined. Dialysis, like reverse osmosis, uses membranes to separate metals from rinsewater. Instead of high pressures, the separation occurs by either placing an electrical charge on the membranes, or by the phenomenon of diffusion. In electrodialysis, charged membranes allow ions of the same charge to pass through. By alternating negative and positively charged membranes, the incoming metals can be separated from the rinsewater. Electrodialysis requires relatively little maintenance and can operate continuously without regeneration. In diffusion dialysis, solutes (metals, acid) move from areas of high concentration to areas of low concentration based on their individual diffusivity, or ability to travel through the membrane pores. Diffusion dialysis is used to separate clean acid from metal contaminants in acid baths. Diffusion dialysis can operate continuously without regeneration and only requires an electrical source to drive the peristaltic pump. Relatively low flow rates must be used to ensure proper separation making diffusion dialysis a slow recovery process.

During the plating process, impurities are introduced into the plate bath solution from several sources: the workpiece, the water or chemicals used to make the plating solution, and from drag out of the previous tank. Additionally, in the rinsewater recovery process, along with the desired plating chemicals, some undesirable impurities will also be separated from the rinsewater and returned to the plate bath. This accelerates the level of impurities already present in the bath. Consequently, plate bath solutions must periodically be purified. Filtration combined with electrolytic migration is a technology which can be employed for this and involves electromotively forcing positively charged impurities through a filter and collecting them on a cathode.

3. Metal Cleaning Facilities

Metal cleaning is an operation employed in a variety of Navy facilities to prepare metals and metal parts to perform satisfactorily in their in-

tended applications. Examples of Navy facilities which require metal cleaning include aircraft repair facilities, electroplating facilities, machine shops, paint shops, and shipfitting facilities. Metal cleaning involves using chemicals to remove dirt, oil, grease, rust, or other contaminants from the metal's surface.

Just as for plating processes, the rinse stage of the metal cleaning process uses the majority of the required water. Rinsing is either conducted by spraying the metal piece or by dipping it into a rinse tank. Generally the rinse tank method consumes significantly more water than spraying. Used rinsewater will contain the chemical(s) used to clean the metal, as well as the metal contaminants themselves. Chemicals typically used for metal cleaning are solvents, acids, detergents, or alkaline substances. The rinsewater must be of sufficient quality so that the metal parts are not contaminated when sprayed or dipped. See Figure 4-8 for the tolerable contamination levels for metal cleaning rinsewater. Contaminated parts will also add the contaminants to the next process tank.

Water conservation options for metal cleaning facilities which use rinse tanks are similar to those for plating facilities. The increased complexity of some metal cleaning rinse solutions may make reclamation efforts more difficult. Reclamation for rinsewater with organic solvent contamination, for example, may require extra treatment steps to extract the solvent. The amount of fresh or reclaimed water needed for the rinse tank may be reduced by reusing water from other sources such as cooling tower discharges and boiler blowdown. Typically, these waters will meet the water quality standards in Figure 4-8. The volumes of wastewater produced from the spray technique may not be large enough to warrant implementing retrofits or recycling/reclamation systems.

4. Painting/Paint Stripping Facilities

Conventional: Painting of items at Naval facilities is usually conducted in hangars (aircraft) or in spray paint booths using spray applicators.

Water is used in spray booth ventilation systems to trap paint particles in the air and flush them away from the operator's breathing space. The water is supplied from a tank and is constantly circulated through the system while the booth is used. Upon replacement with fresh water, the paint-contaminated water must be treated as hazardous waste.

Paint stripping of items at Naval facilities is also conducted in hangars or other isolated work areas. Water is used as a rinse to clean off the applied chemical stripper and the loose paint. Depending on the size of the object, the quantity of rinse water can be significant. Items such as aircraft are spray rinsed, smaller items are generally dipped in rinse tanks.

Operational and Maintenance Procedures: The simplest conservation

option for paint/ paint stripping facilities is to alter operational procedures. For paint spray booths:

- Reduce the flow of the water to minimum levels that will still catch the airborne paint.
- Recirculate the water more times through the booth before replacing it.

For paint stripping facilities:

- Squeegee off used stripper and loose paint instead of flushing with water in spray rinsing applications.
- Repair leaks in rinse tank connections.
- For rinse tanks, many of the water conservation measures used in plating facilities can be applied.

Replacements: For paint spraying booths: the wet spray booth can be replaced with a dry spray booth. A dry booth uses filters instead of water to extract airborne paint particles from the atmosphere and exhausts any solvent fumes as well. This system eliminates the generation of wastewater which must be treated on-site or disposed of as hazardous waste. The filters are simply exchanged when they become fouled. Dry spray booths are relatively low in cost and easy to install. Figure 4-11 illustrates two types of dry booths.

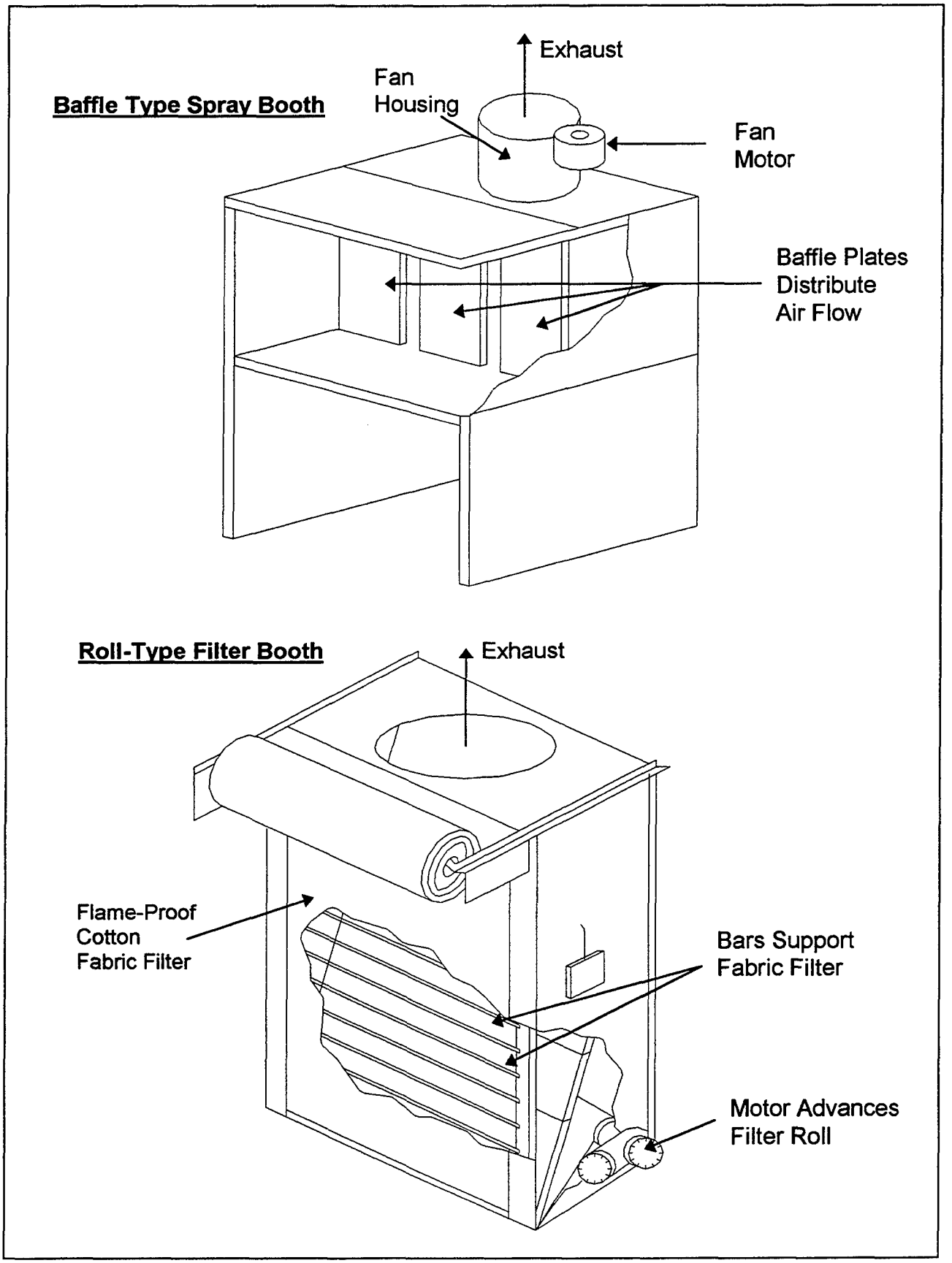
Another option for painting smaller parts is to replace the traditional liquid coatings with powder coatings. Powder coatings are attracted and attached to the workpiece surface in the form of charged particles, then permanently fused to the surface with high temperature baking. Using powder coatings eliminates the need for exhaust vents and scrubbers for fumes and water sprays for paint collection, and will not produce "paint overspray". No hazardous wastewaters are generated. The cost of installing a powder coating booth system is competitive with installing a liquid coating booth.

For paint stripping facilities, the method of PMB, Plastic Media Blasting, may be an appropriate replacement for chemical strippers. The plastic beads used for blasting are nontoxic and will not harm or etch the workpiece's surface (as sand blasting may). A PMB system also includes a media reclaimer device to collect and recycle the plastic beads after use. Dangerous solvent strippers and water used for rinsing are eliminated. Therefore, no hazardous wastewater is generated.

Recycling and Reuse: Wastewater from painting or paint stripping facilities may contain a number of hazardous chemicals, making it difficult to treat for reuse in the same process. The treated water may, however, be suitable for reuse in other applications such as irrigation. Depending on the complexity of the wastewater, extensive treatment might not be cost effective.

Alternately, water from other sources can be used in paint stripping rinse tanks and paint spray booths, as long as the water meets the quality standards listed earlier. (Figure 4-8) As for metal cleaning facilities, cooling tower discharge and boiler

Figure 4-11: Two Types of Spray Booths



blowdown water may be suitable water sources for painting/paint stripping rinse water.

5. Industrial Laundries

Conventional and New: The conventional and new designs of washers, along with their corresponding water consumption, were discussed in the previous section, "Washing Machines". Front-loading, horizontal-axis washers are a more common sight in commercial and industrial laundry facilities than they are in residential homes and thus these facilities are more advanced in the practice of regularly conserving water. Most large industrial or institutional laundries use what are termed "washer/extractors" which are larger versions of the residential washer and provide more cycle options.

The Navy operates laundry facilities to clean linens, uniforms, street clothes, etc. The laundry facility may be a self-serve laundry where base residents and personnel wash their own clothing, or it could be a commercial-type laundry service where base residents drop off laundry to be washed or dry cleaned, or it may be an industrial laundry facility where large volumes of navy-owned linens and uniforms are cleaned. Large amounts of water are regularly used in industrial laundries, making them highly suitable for a water conservation program.

Operation and Maintenance Procedures: The procedures given earlier under the section "Washing Machines" can be applied to industrial laundries that use conventional washers.

Retrofits: The only retrofits for industrial laundries would be the addition of recycling equipment. See Recycling and Reclamation below.

Replacements: Besides replacing top-loading, vertical axis washers with horizontal-axis models, there are two major replacement options which may be considered. They are best suited for larger industrial/commercial type laundries, rather than self-service laundries.

"Tunnel washers", also known as "continuous batch washers", are heavy-duty, multi-tank systems for use in large industrial laundries. They are capable of handling up to 1000-2000 pounds of laundry per hour, although smaller versions are manufactured also.

Tunnel washers work by automatically moving batches of laundry from one tank to another and agitating the batches in each tank. The fresh water flows in the opposite direction, much like a plating facility counter-current rinse system, from the cleanest tank (rinse) to the washing tanks.

Continuous batch systems are costly to install (up to several $100,000), but are capable of saving 60-70% of the volume of water used with a washer-extractor, and require less operating and maintenance labor. The system modules use more floor space than extractors, but also handle more laundry.

The second replacement option is ozone laundering. A fairly new process on the market, it could be considered a type of retrofit for commercial laundries' existing washers, but it cleans the laundry by such a unique approach, it is more accurately described as a replacement for the regular way of washing. Ozone laundering is suited for lightly to moderately soiled laundry. It uses no detergent (although a separate tank for detergent washing is sometimes used for final cleaning of heavily soiled items), uses only cold water (absorbs ozone better than warm), and recycles water.

Ozone-generating equipment is attached to the washer as a closed-loop system. It generates the ozone which saturates the cold water supply. The saturated water is then used as the wash water. Ozone is a known powerful disinfectant and oxidizing agent and thus acts like chlorine eliminating the need for detergents, thus diminishing the rinse cycles and rinse water discharge. Filters are used to collect dirt and residue from the water before it is resaturated with ozone and returned to the wash cycle.

Although ozone is considered toxic at certain concentrations, equipment manufacturers claim that ozone laundering systems release less ozone to the atmosphere than a copier machine. Ozone rapidly degrades in water to molecular oxygen, so there is no danger in handling the wet laundry after the cleaning process has finished. Ozone laundering has been used at several large institutions with good results. It is capable of cleaning the laundry without substantial graying or degradation of the fabric.

Recycling and Reclamation: Rinse water can usually be recycled to the wash cycle for the next laundry load with no chemical treatment. The addition of some fresh water is required to bring the water quality to desired levels for use in the wash load, and some filtering may be needed to catch lint and sediments. Implementing a rinse recycling system is relatively inexpensive and can reduce water usage by 30%.

Washwater, on the other hand, must be treated before it can be recycled back into the wash process. Figure 4-12 gives the typical "before and required-after" chemical composition of laundry water. Many washwater recycling treatment systems use inorganic coagulants to draw out water impurities in the form of a sludge. Other systems use step-wise processes, including filtration and carbon adsorption, to remove various wastewater components.

Depending on effluent quality, rinse or washwater can be reused as graywater for applications such as irrigation and preliminary rinsing at washracks.

Problems and Pitfalls: Ozone laundering uses electricity to generate the ozone, causing an increase in energy demand for this system. However, this increased energy demand can potentially be offset by the

Figure 4-12: Industrial Laundry Water Quality

Parameter	Raw Wastewater (mg/L)	Recycle Criteria (mg/L)
Benzene	2.5	0.1
Biochemical Oxygen Demand (BOD)	1,300	30
Chloroform	3.3	0.1
Chromium	0.88	0.1
COD	5,000	100
Copper	1.7	0.1
Lead	4.5	0.1
Nickel	0.29	0.1
Oil & Grease	1,100	10
Perchloroethylene	9.1	0.1
Suspended Solids	1,000	***
Toluene	5.2	0.1
Zinc	3	0.1
Color	---	***
Hardness	---	50 mg/L as CaCO3
Odor	---	***
pH	---	7 -8
Total Dissolved Solids	---	2,000

Note: *** None Allowable, must be below detection limits.

savings in energy not expended on water heating.

For recycling, the main concern is making sure the water quality is at acceptable levels for the water's future application. Bacterial control is especially important in medical settings.

D. HVAC Equipment

1. Cooling Towers, Evaporative Coolers, and Once-Through Cooling Systems

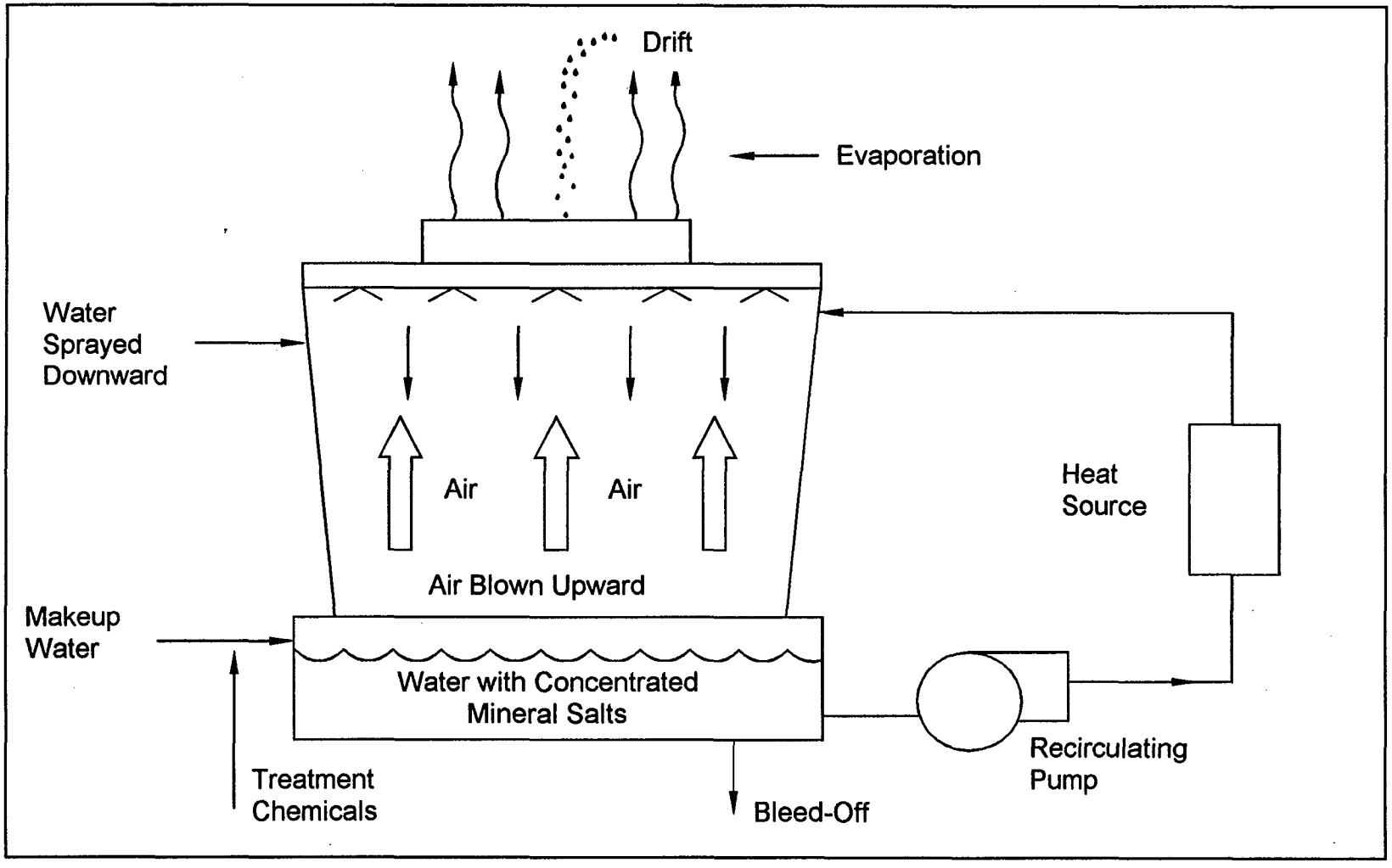
Conventional: Cooling towers, evaporative coolers, and once-through cooling systems are some of the largest users of water in facilities with air conditioning or cooling loads. Recall Figure 1-6, which showed how much water is used by office building cooling and heating systems. Only restrooms consume more water.

Once-through cooling systems are used for evaporative coolers, ice-makers, hydraulic equipment, and air compressors. They do not recirculate the water, discharging it after using it once. Once-through cooling wastes water unnecessarily.

Cooling towers are the most common type of cooling system for large cooling loads. Cooling towers are used to cool equipment such as air conditioning systems. They work by circulating a stream of water to the equipment and back. The circulating water is cooled by evaporation. A water spray travels against an air flow resulting in a portion of that water evaporating. The water that is left is cooled by heat exchange to the evaporated water droplets. The cooled water travels to the equipment that requires it. There, heat is transferred from the equipment to the water, and the warmed water then returns to the cooling tower to be recooled. Figure 4-13 shows a typical cooling tower in operation.

Water loss in the recirculating system normally occurs in three ways: by evaporation, bleed-off, and drift. Make-up water must be added to the cooling tower to replace the lost water. Evaporation is the natural process by which the tower cools the water. It can be estimated that the evaporation rate in a cooling tower equals approximately 2.4 gpm per 100 tons of (1.2 million BTU's per hour) cooling. Drift results when water droplets are carried away from the tower by the air flow. Drift usually contains sediment material and is considered part of bleed-off. Only 0.05 to 0.2% of the cooling tower's water is lost through drift. Bleed-off is the portion of recirculating water which is purposely released from the tower to remove accumulated impurities. Suspended and dissolved solids accumulate in the circulating water as evaporation removes pure water vapor and increases the concentration of impurities in the water left behind. The solids are introduced into the water through the make-up water, from the air used in evaporation, or through corrosion in the recirculating plumbing. Bleed-off is the only use of water that can effectively be reduced by water conservation.

Figure 4-13: Typical Cooling Tower Operation.



Source: Water Management: A Comprehensive Approach for Facility Managers.

The water savings realized by implementing the following suggestions depend on your individual cooling system setup. However, an estimation can be made that for a 300-ton cooling tower operating daily at 60% capacity, increasing the water circulation cycles (before bleed-off) from 2 to 4 can save 1.5 MG/YR.

Operation and Maintenance Procedures:

- Check and repair leaks. Repair any malfunctioning equipment.
- If a conductivity meter is installed, change the method of releasing bleed-off from a batch method to a continuous method. The batch method involves discharging a large quantity of bleed-off automatically when the water's conductivity reaches a certain preset level. This causes fluctuations in the conductivity of the circulating water and causes the average conductivity to be lower than necessary. Continuous, low volume bleed-off keeps the conductivity steady at the desired level, which conserves water and reduces the need for treatment chemicals.
- Reduce the amount of bleed-off to the minimum volumes that still produce acceptable circulating water quality.
- Controlling the amount of bleed-off by the use of chemical additives to the water can be considered a maintenance procedure once established. Chemical treatment methods are discussed in the section below, after Retrofits and Replacements.

Retrofits: The following suggestions will aid in reducing the amount of bleed-off to minimum levels consistent with good operating practices:

- Install flowmeters to monitor the flow of both make-up and bleed-off water to determine any required flow changes.
- Install a conductivity meter to determine proper frequency of bleed-off. (See Operation and Maintenance Procedures above)
- Install a timer to shut off the cooling tower when cooling is not needed, such as at night when the facility is unoccupied.
- Sidestream filtration - water is temporarily routed away from the cooling tower through special filters which filter out particles and suspended solids. The cleansed water is then returned to the cooling tower for use, thus reducing bleed-off. The cost of implementing a sidestream filtration system is moderate and requires the addition of energy to run the water pumps. Also, some solids are not as effectively removed as others.

Replacements: Replacing a cooling tower system is a large financial investment and is generally not cost-effective unless the existing cooling tower is extremely old, corroded, or malfunctioning and unrepairable. It

is the incorporation of the above suggested procedures and retrofits which make the real difference in water use.

Once-through cooling systems, on the other hand, should be eliminated when possible, since they waste significant amounts of water by not recirculating it. They can be replaced by air-cooled models.

Chemical Additives: The quality of the air stream through the cooling tower and the quality of the make-up water are the major contributors to the quality of the circulating water. Accumulation of contaminants from these sources in the circulating water can lead to scale, corrosion, and biofouling of the cooling tower. Scale is a film of mineral deposits which forms on the surfaces of the circulating plumbing, causing a reduction in water flow and thermal efficiency. Corrosion in the cooling water system results from the water being too acidic, containing a large concentration of metals (causing galvanic corrosion), or being too high in oxygen content. Biofouling is caused by the growth of algae or bacteria in the water to the point that it impedes proper water flow.

Chemicals are generally needed in cooling towers to control these afflictions that necessitate bleed-off. By controlling scale, corrosion, biofouling, and other foreign matter, chemicals reduce the amount of bleed-off required and thus conserve water. Organophosphates are typically used as scale and corrosion inhibitors, while a number of biocides such as chlorine inhibit fouling. These chemicals are best introduced into the cooling tower system by automatic feeders which respond to the conductivity of the circulating water. There are numerous vendors available who specialize in determining the proper types and dosages of chemicals for cooling towers. A qualified vendor is one that is able to perform to specifications and maintain a preset level of water chemistry. There is a chemical treatment approach that warrants special mention because of its effectiveness in maintaining cooling tower water quality: sulfuric acid treatment.

Sulfuric acid, when added to recirculating tower water, lowers the pH of the water and "digests" metal solids such as calcium bicarbonate (primary cause of scale), thus solubilizing water sediments. Sulfuric acid treatment reduces the amount of bleed-off required by increasing the number of times the water can recirculate. Sulfuric acid is corrosive, however, and care must be taken to ensure that workers do not physically come in contact with it, or that the cooling tower system is not damaged (corrosion) by adding too much (causing a very low pH). The cost of incorporating and operating a sulfuric acid system is relatively low. Discharge of the bleed off may become a problem due to the lowered pH and sewer district restrictions on allowing acidic solutions into the sewer.

Ozone Injection: Ozone generators have proven very effective in biocidal treatment of circulating water in

cooling tower systems. Ozone injection has also shown some effectiveness in reducing system corrosion and scaling, although this process will usually not preclude the need for chemical treatment.

Reuse and Recycling: Depending on quality, the make-up water for cooling towers can come from a variety of sources such as once-through coolers, reject water from RO systems, and high quality municipal wastewater effluent. Incoming make-up water may need to be pretreated by ion exchange, filtration, or lime softening.

Cooling tower discharge is usable with little or no treatment in many applications which don't need high purity water. This depends on the levels of contaminants and/or additive chemicals present. Examples include irrigation, washracks (except final rinse), and paint booths.

Additionally for once-through coolers, if they cannot be eliminated, they may be able to be converted to recirculating systems by connecting them to nearby cooling towers.

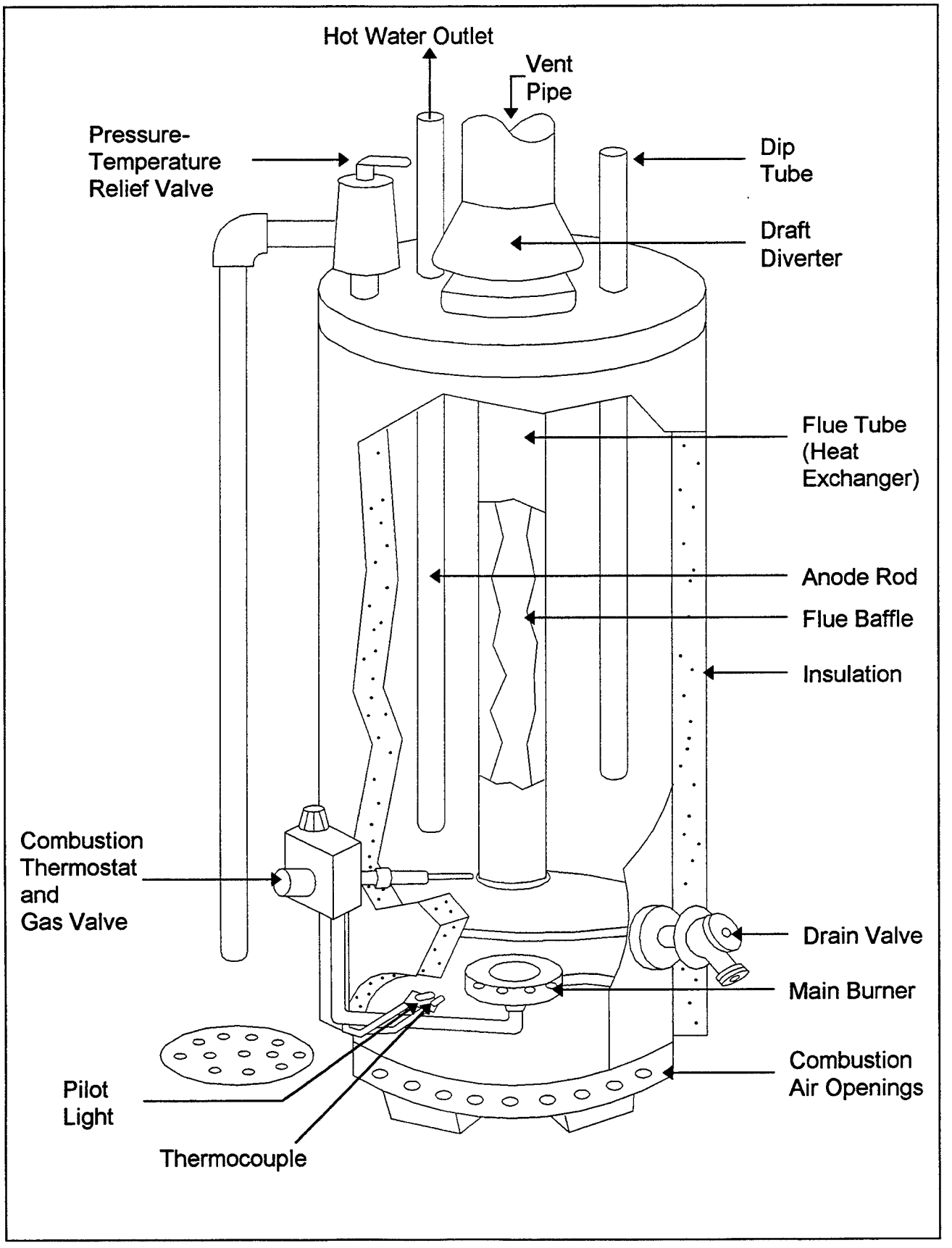
Magnets/Electrostatic Field Generators: You may have heard claims from some manufacturers about the effectiveness of magnetic or electrostatic systems to settle out contaminant particles in cooling tower water by altering their charge. These claims are, to date, experimental, controversial, and unproven. More investigation is needed before these treatment systems can be recommended (or disapproved). Consequently, they will not be elaborated on in this manual.

2. Water Heaters

Conventional and New: Although water heaters are common in residential houses and offices, they also supply hot water for industrial processes and thus will be discussed here.

Water heater designs are varied throughout the world. Whereas the "tankless" water heater (discussed below) is common in Europe, water heaters in the U.S. and Canada are generally the familiar large central tank type. They are either fueled by electricity or natural gas, and have a thermostat, properly called an "aquastat", which activates resistance heating coils inside the tank (electric) or the gas burner (natural gas) when the water temperature drops below the setpoint. The newer water heaters on the market are geared toward being very energy efficient in comparison to older models. Conservation of water in these new tanks occurs as a result of these energy efficient features. For example, new water heaters allow better control over the temperature of the outgoing water which reduces the amount of water consumed. You can improve and maintain the water and energy efficiency of your water heaters by implementing the suggestions given below, as appropriate for your facility. A schematic of the inner components of a typical natural gas heater is shown in Figure 4-14 for reference.

Figure 4-14: Typical Natural Gas Water Heater



Operation and Maintenance: Proper maintenance of existing water heaters is important because of two major problems which affect them: scale/ sediment buildup and corrosion. These problems, if left unchecked, can decrease the efficiency of a water heater or even destroy it. Scale and sediment form in hard water environments, corrosion results when soft water is used (to control hard water deposits). The hotter the water, the more accelerated is the scale and corrosion formation, due to the increased formation of corrosive gasses like oxygen and lime deposition. Scale, sediment accumulation, and corrosion decrease the water heater's ability to transfer heat to the water, causing it to consume more energy. Most water heaters employ a "sacrificial" anode which is put in the tank to preferentially corrode when galvanically coupled to the tank. New water heaters also are usually lined with fiberglass or plastic to protect metal parts from corrosion. Even with these internal corrosion inhibitors, maintenance procedures should be performed to keep the water heater at peak performance.

- Periodically (annually or as needed) drain the water heater and flush out any sediments.
- Inspect the anode and replace if completely corroded.
- Reduce the temperature setpoint - new water heater units are being designed to be set to as low as 110°F, although 120°F is the standard. During the 1980's, water heaters were usually set to 140°F and before this, to 150°F. For typical household use, 120°F is sufficiently hot.
- Operationally, users should be discouraged from operating hot water taps for short periods of time when they have no need for hot water. This unnecessarily draws hot water from the water heater and lets it cool unused in the pipes.

Retrofits: There are a number of retrofits that can be performed on a water heater to save heat energy and consequently conserve water.

- Insulation - newer water tanks are being made with internal insulation. However the addition of insulation around the tank wall, the bottom board, the pipe-tank connections and outward distribution pipes can make a significant difference in the water staying hot. Be careful NOT to insulate below the drain valve or near the top vent as this may cause carbon monoxide to be released, or produce a fire hazard.
- Consider installing smaller-diameter pipes, if allowed under plumbing codes, to decrease the surface area and thus the cooling rate of the traveling water.
- For new construction, locate the end-use devices closer to the water heater, and choose a heated area for the water heater itself to be installed in.

- Install timeclocks to automatically shut-off electric heating elements during periods of non-use.
- Install an auto-setback control - it adjusts the aquastat set-point to the required level right before a time of peak demand, then lowers it during periods of low demand.
- Install a premixed water distribution system - a system that is installed between the water heater and the end-use devices. It allows the user to control the water temperature and flow rate precisely by mixing hot and cold water in a central valve unit. This reduces the amount of water wasted attempting to achieve a desired temperature.
- Install a 360 degree loop heat trap - an extra circular or square loop on both the inlet and the outlet pipes just above the tank connections. This keeps water driven by convection from traveling from the water heater.
- Anticonvection valve - also used to impede convection-forced water flow. It works by using a floating ball and seat. Currently, U.S. manufacturers are providing these valves (inlet and outlet) of as standard equipment on heaters.
- Hot water recovery system - minimizes the loss of leftover hot water in the distribution pipes by drawing it back to the tank. This unit is generally not very large and is mounted on top of the water heater.

Replacements: Old, inefficient water heaters should be replaced with today's energy efficient models. Avoid tall thin tanks in favor of shorter, fatter ones which retain heat better by reducing the outward surface area of the water.

Tankless water heaters, common in Europe, do not use a storage tank, but instead heat water as it is drawn for a particular task. This eliminates "standby" heat loss experienced in water heater tanks when there is no demand. Tankless water heaters have limited flow rates and higher installation costs. In a sense, they may actually cause the user to waste more water knowing that the hot water supply will never run out, as it does in a tank system. Tankless water heaters are well-suited to applications where continuous hot water is required for discrete and known periods of time, such as in gym or health club locker rooms.

A more radical replacement is a solar system. New advances in the area of solar energy have led to a variety of solar water heater designs being manufactured and marketed. The primary goal of these systems is to save energy. The correlation between energy savings and water savings depends on the design and setup of the system and needs to be investigated for each situation before considering implementation.

3. Boilers and Steam Generators

Boilers and steam generators are used at facilities that need large amounts of steam for heating or generating electricity. Boilers use varying amounts of water to produce steam, depending on their size. They require make-up water to compensate for uncollected condensate, or replace blow-down water. Blow-down water is water periodically released from the boiler to remove accumulated solids and sediments. The following options and procedures will help conserve water in boilers and steam generators.

Operation and Maintenance Procedures:

- Inspect equipment regularly.
- Check and repair leaks in the steam traps. Escaping steam wastes water and energy. The steam traps can also be easily replaced, if needed.
- Limit the amount of blowdown to the minimum required for properly flushing the system and reaching the desired water quality. Avoid using a continuous blowdown system.
- Ensure that piping and storage tanks are insulated.

Retrofits:

- Use a timer or automatic controller to turn the boiler off during non-use periods (e.g., nights and weekends).
- Install a condensate return system. This allows the condensate to be returned as make-up water, saving up to 50 -70% of water use, while lowering operational costs due to higher temperature feed water.
- Use an expansion tank to collect blowdown water and permit cooling for discharge.
- Consider using a heat exchanger to preheat boiler feedwater and cool blowdown.

Replacements: Unless the existing boiler is very old or beyond repair, it may be much more cost-effective to follow the suggestions above rather than to replace the system. Replacement systems vary according to size and application. Consult a system vendor for advice about your facility.

Chemical Use: The addition of corrosion and scale inhibitors will aid the boiler to work efficiently, extend its life, and reduce water consumption due to a lessened blowdown demand.

Reuse: Depending on the water quality, boiler blowdown may be used in other water consuming applications like irrigation.

E. Medical Facilities

Other than the common water demands for restrooms, laundries, and cooling & heating, Naval medical facilities have some unique water demands based on their use of specialized equipment. Water conservation options are presented below for this equipment.

1. X-Ray Equipment

After x-rays are taken, special automated processing equipment is used to develop the film. Water is used during the process to rinse the film of its developing chemicals and silver compounds used to create x-ray images. There are several operational or equipment modifications which can reduce the equipment's water use.

Operation and Maintenance Procedures:

- Check and repair leaks.
- Reduce flow to manufacturer's specification.
- Maintain the solenoid control valves in good working order.

Retrofits:

- Install flow meters to allow equipment users to control the amount of rinse water used by the processor. A flow rate of 2 gpm is normally sufficient.
- Add solenoid valves to shut-off rinse and cooling flows when processor is idle.
- Install regulators to automatically limit the flow rate of the rinse water.

Recycling: Recycle the rinse bath effluent into make-up water for the developer solution. Implement a silver recovery unit to collect the valuable metal for reuse in another application.

2. Sterilizers and Autoclaves

Sterilizers and autoclaves can consume significant amounts of water depending on their age (older units have little or no flow control) and rate of use. Some facilities may operate one or more sterilizers 24 hours a day. Below are some suggestions to conserve water in these units.

Operation and Maintenance Procedures:

- Adjust flow rates to the minimum rates recommended by the manufacturer.
- Shut off the unit when it is not being used for an extended period of time.
- Use a high quality steam supply for improved water efficiency.

Retrofits:

- Install an automatic shut-off controller to shut down water supply when unit is not in use.
- Install flow meters and controllers on older units.

Replacements: When purchasing a new unit, select one with automatic shut down features and flow controls. Some new sterilizers also have recirculating capabilities.

F. Recreational Facilities Swimming Pools and Spas

Though swimming pools and spas may account for only a small percentage of the total water used at a Naval base, there are some simple steps that should be implemented to reduce unnecessary wasting of water while conserving energy.

- Cover the pool or spa when not in use. A pool cover can reduce water evaporation by as much as 90-95%. It reduces the need for pool filter backwashing by keeping out foreign matter, and it acts as a solar heater when placed over outdoor pools and spas.
- Lower the water level in the pool or spa. This prevents water loss due to splashing, and also decreases the total volume of water that must be heated and cleaned.
- Use chemicals properly to maintain water quality and reduce the need for cleaning and refilling.
- Avoid excess filter backwashing.

For new construction, consider indoor rather than outdoor pools and spas. They require less heating, experience less evaporation, and require less cleaning.

G. Irrigation and Landscaping

Irrigation accounts for approximately 25 - 30% of the total water use for urban facilities. Inefficient irrigation and landscaping practices are estimated to waste 40% of this. There are many water conservation options available to reduce or eliminate this waste and cut your facility water costs dramatically. For existing landscaping, a number of maintenance procedures, retrofits, and replacements are given. For new construction or complete relandscaping, the concept of xeriscape™ is discussed.

Operation and Maintenance Procedures: For existing landscaping, the following suggestions will apply:

- Monitor for leaks and clogged or malfunctioning equipment. Repair as needed.
- Place sprinklers or sprinkler heads strategically so they water only the desired areas, not sidewalks or roadways.
- Water in the morning rather than midday or evening. Watering in midday wastes water through high evaporation rates; watering in the evening and leaving the turf or plants wet overnight encourages disease.
- Adjust the water schedule to seasonal water demand.
- For most landscaping plants, water deeply and infrequently, rather than lightly and often. This encourages deep roots.
- Mow turf to the proper height depending on type. Decrease nitrogen fertilizers to improve drought resistance. Aerate turf soil and dethatch the turf to improve water penetration.
- Control weeds to reduce competition for the water.
- Water low to the ground rather than high in the air to reduce evaporation losses and more accurately project the water to the desired area.
- Use mulches to retain moisture in the soil around plants and shrubs.

Retrofits:

- If watering is done manually, install an adjustable sprayer on the hose. If appropriate, install one that shuts off automatically when the lever is released.
- If an automatic irrigation system exists, install updated sensors and controls. Install a timer to automatically activate sprinklers according to a set schedule.
- Install soil tensiometers to monitor soil moisture. Tensiometers can be wired to the irrigation system's controller to activate the sprinklers when the soil is dry.
- Install a cathodic conditioner in the sprinkler system to reduce water pressure. This reduces the amount of water sprayed from the sprinkler heads.

Replacements: Replacing an older sprinkler system or a manual one with an updated automated system can save large quantities of water.

One replacement option is to replace the sprinkler heads. Sprinkler head design should be consistent with its desired watering function. For example, low-flow heads should be used in areas with flowers, trees and shrubs, while higher flow heads should be used for turf (where the water must be sprayed over its target area). Some low-flow heads are referred to as "bubblers" because the water is bubbled rather than sprayed.

Another option is drip irrigation. Drip irrigation delivers the water through small diameter tubes connected to pressure-compensating nozzles called emitters. Some emitters can be buried below ground (subsurface) with their tips located slightly above grade to produce the water drip or trickle. Water flow is reduced from the normal gallons per minute used by traditional sprinkler heads to gallons per hour. A simplified version of drip irrigation is the "soaker" hose. A soaker hose looks like a garden hose but contains many tiny holes which allow water to seep out very slowly to nearby plants. A soaker hose can be buried under the soil surface and is an easy and efficient alternative to manual hose watering. More sophisticated subsurface irrigation systems are also available. Drip irrigation is not recommended for turf lawns which require a more uniform application of moisture. It is highly suited to gardens, shrubs, trees, and flower beds.

Replacement of the plants and turf used in your landscape is discussed in the section below.

Xeriscape™: The word xeriscape™ comes from the Greek word "xeros" meaning "dry". Xeriscape™ refers to a comprehensive landscaping program which takes into consideration that water is a precious resource which must be conserved. It means implementing landscaping procedures which will produce quality landscapes with limited water use. The benefits of xeriscape™ are numerous: reduced water bills and maintenance, increased drought re-

sistance, improved aesthetics, and increased horticultural diversity, just to name a few.

Xeriscape™ is an involved process with seven distinct steps. It is best applied to new landscaped areas or to areas in which you are willing to completely redo the landscaping in order to implement these seven steps. The seven xeriscape™ steps are given below with a list of related suggestions for each.

1. Planning and Design--Examine the site and all the factors which will determine the best design and choice of plants for the area:

- Drainage requirements
- Sun exposure and areas of shade
- Directional orientation
- Concrete areas
- Weather and precipitation patterns
- Water availability and cost
- Existing plant/lawn locations and characteristics

2. Limited Turf Area--Part of xeriscape™ involves replacing areas of turf with other plant materials. Turf uses more water than most other plants and thus it should be used sparingly in your landscaped areas. For remaining turf areas, drought resistant species of grass which are native to the area should be selected. Figure 4-15 presents a number drought resistant plants.

3. Efficient Irrigation--Many of the procedures and replacements listed previously can be applied (e.g., watering in the mornings versus evenings):

- Irrigate turf areas separately from other plants
- Separate high and low water use plants
- Drip irrigation and low volume spray/bubblers for nonturf areas.
- Catch rainwater and apply to irrigated areas.

4. Soil Improvements--Healthy soil reduces water use and helps plants and turf to thrive:

- Analyze soil to determine type and needed treatment
- Incorporate organic matter
- Till the soil to keep it loose and aerated
- Incorporate water-retaining material into the soil

5. Use of Mulches--Organic mulches improve the condition of the soil and allow it to retain more moisture. They also help to control weeds.

6. Use of Low-Water-Demand Plants--Hundreds of low-water-use plants are available to conserve water, replace turf, and create a very appealing landscape. (See Figure 4-15). Higher water-use plants should only be used in areas with sufficient rainfall or in low-lying areas which receive irrigation or rain runoff. Plants with like-water demands should be

Figure 4-15: Drought Tolerant Plants

TREES
Acacia (many)
Aesculus californica
Ailanthus altissima
Albizia julibrissin
Brahea armata
Calocedrus decurrens
Casuarina
Cedrus deodara
Celtis
Ceratonia siliqua
Cercidium
Eriobotrya japonica
Eucalyptus (most)
Fig (edible)
Geijera parviflora
Grevillea
Koelreuteria paniculata
Lyonothamnus floribundus
Maclura pomifera
Melia azedarach
Olea europaea
Parkinsonia aculeata
Pinus (many)
Pistacia
Populus fremontii
Quercus (many)
Rhus lancea
Robinia
Schinus molle
Schinus terebinthifolius
Sequoiadendron giganteum
Tilia tomentosa
Tristania conferta
Ulmus pumila
Walnut
Ziziphus jujuba
SHRUBS
Acacia (many)
*Arbutus unedo
Arctostaphylos
Artemisia
Atriplex
Baccharis pilularis
Caesalpinia gilliesii

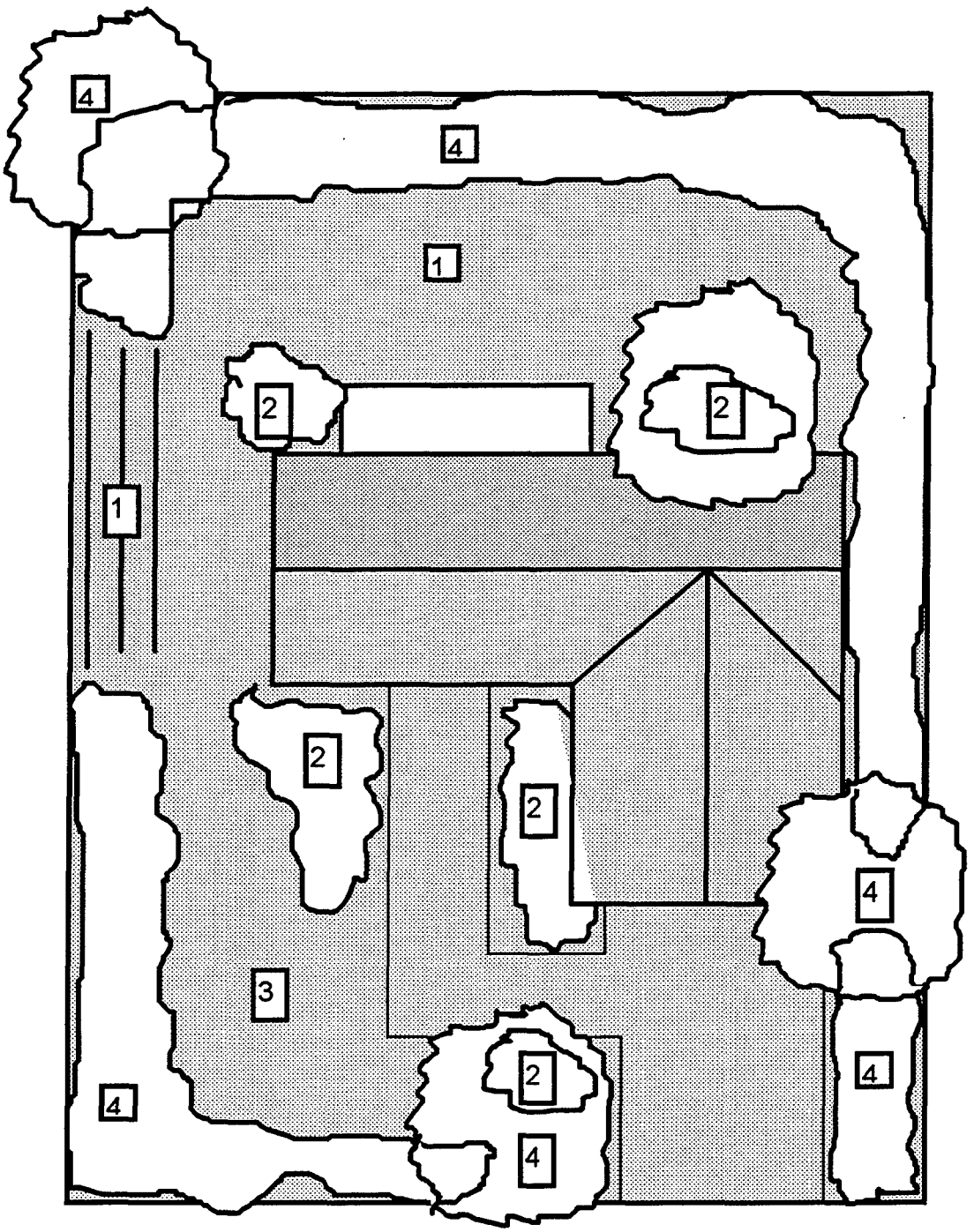
*Calistemon citrinus
Capparis spinosa
*Caragana arborescens
Cassia artemisioides
Catha edulis
Ceanothus
*Cercis occidentalis
*Cercocarpus
*Chamaerops humilis
Chamelaucium uncinatum
Cistus
Convolvulus oneorum
Coprosma kirkii
*Cotinus coggygria
Cotoneaster
Crassula argentea
Crassula falcata
*Cupressus glabra
Cytisus
*Dalea spinosa
Dendromecon
*Dodonaea viscosa
Echium
Elaeagnus
Escallonia
Fallugia paradoxa
Fremontodendron
Garrya
Genista
Grevillea
*Hakea
*Heteromeles arbutifolia
Hypericum calycinum
*Lagerstroemia indica
Lantana
Lavandula
Lavatera assurgentiflora
Leucophyllum frutescens
*Lysiloma thornberi
Mahonia
*Melaleuca (most species)
Myoporum debile
*Nerium oleander
*Photinia serrulata
*Pinus edulis

*Pinus monophylla
*Pittosporum
Plumbago auriculata
Portulacaria afra
*Prosopis glandulosa torreyana
*Prunus caroliniana
*Prunus ilicifolia
*Prunus lyonii
*Punica granatum
Pyracantha
*Rhamnus alaternus
Rhamnus californica
*Rhamnus crocea ilicifolia
Rhus ovata
Rosa rugosa
Rosmarinus officinalis
Salvia clevelandii
Salvia leucantha
Santolina chamaecyparissus
Simmondsia chinensis
Sollya heterophylla
Spartium junceum
*Tamarix
Taxus
Teucrium
Trichostema lanatum
*Xylosma congestum
VINES
Bougainvillea
Cissus trifoliata
Tecomaria capensis
Wisteria
PERENNIALS, BULBS, ANNUAL
Achillea
Agave
Aloe arborescens
Amaryllis belladonna
Anacyclus depressus
Arctotheca calendula
Baccharis pilularis
Baptisia australis
Carpobrotus
Centranthus ruber
Cleome spinosa

Coreopsis
Cortaderia selloana
Dietes vegeta
Dudleya brittonii
Echeveria (most)
Eriogonum
Euphorbia (most)
Euryops
Gaillardia
Hippocrepis comosa
Iris, bearded
Iris (Pacific Coast natives)
Kniphofia uvaria
Leonotis leonurus
Leucocoryne ixioides
Liatris
Limonium perezii
Linum
Marrubium vulgare
Mimulus
Narcissus
Oenothera berlandieri
Pennisetum setaceum
Perovskia atriplicifolia
Phlomis fruticosa
Phormium
Polygonum cuspidatum compactum
Portulaca grandiflora
Puya berteroniana
Romneya coulteri
Sedum (many)
Sisyrinchium bellum
Tithonia rotundifolia
Verbena
Yucca (most)
Zauschneria
TURFGRASS
Buffalograss
Bermudagrass
Zoysiagrass
Bahiagrass
Crested Wheatgrass
Hard Fescue
Sheep Fescue
Red Fescue

*** Can become a small tree.**

Figure 4-16: Sample Yard Xeriscape™



Zone 1	Turfgrass and vegetable garden with high water requirements.
Zone 2	Exotic shrubs with moderate water requirements.
Zone 3	Continuously rooting ground cover with low water requirements.
Zone 4	Native adaptive trees and shrubs requiring supplemental irrigation only during the establishment period.

grouped together and watered accordingly. Figure 4-16 shows a sample drawing of a proper xeriscape™ yard with a small turf area and contiguous plant groupings.

7. Appropriate Maintenance--

- Weeding and pruning as needed
- Equipment adjustments
- Mowing turf to proper heights

Water Reuse in Irrigation: As mentioned previously in this manual, wastewater from other water-consuming applications can be treated and used for irrigation. Sources of this graywater include showers, restroom sinks, and washing machines.

However, a graywater system must be implemented with caution. Increasingly, many state and local agencies are placing restrictions on using graywater for irrigation because of its possible bacterial health hazards. State or local regulations may require that the graywater treatment system include a combination of sedimentation, filtering, and chemical coagulation processes, along with disinfectants, to remove disease-causing bacteria. Some agencies may also require the graywater to be used only for subsurface irrigation. Graywater should not be allowed to directly contact any edible fruits and vegetables. Graywater typically has a slightly alkaline pH and may be unsuitable for certain acid-loving plants and shrubs.

CHAPTER 5 WATER CONSERVATION SOFTWARE

There are a number of software programs available which address water issues. Several deal with water use or specifically, water conservation. The more pertinent of these will be briefly previewed in this chapter along with vendor data should you wish to obtain further information or the programs themselves.

This listing is not all inclusive, and the NFESC is not endorsing or promoting the use of any or all of these products, but merely includes them here for informational purposes to inform the reader of some of the many sources of support available.

A. FEDS, Facility Energy Decision Screening

FEDS, Facility Energy Decision Screening, 3.0 for Windows is a DOE-FEMP sponsored energy conservation program having a limited water component. It focuses on targeting and prioritizing buildings and end-use retrofit projects for conserving energy. Water conservation is addressed only as it relates to energy savings (e.g., water heaters).

FEDS allows detailed energy information to be inputted and in return, provides detailed project-by-project information about retrofit technology selection and economic information. It helps the user to estimate post-retrofit energy consumption, initial installed cost of the retrofits, recurring costs of the retrofits, value of the change in energy consumption and operation and maintenance requirements, and net present value of the retrofits.

Vendor Information:

U.S. Department of Energy
Office of Federal Energy Management Programs
Code EE-44
Washington, D.C. 20585

Ph: (800) 566-2877
(FEMP Helpline)
Ph: (202) 586-6784
(Dean DeVine)

B. IWRAPS, Installation Water Resources Analysis and Planning System

IWRAPS, (Installation Water Resource Analysis and Planning System) is a water forecasting tool for military facilities. It is part of the Water Resources Planning Series for Shore Navy Installations developed by the Corps of Engineers' Institute for Water Resources.

IWRAPS contains water-use coefficients developed from actual data obtained from a nationwide survey of military bases. Based on building square footage and base population and weather data, it can be used to predict future water requirements for such things as plumbing fixtures, irrigation, and vehicle washing units.

The user must input any known efficiency data on the installed retrofits. In return, the program will calculate water usage for the installed devices. Additionally, this program may be used to "back-cast" water data for use in water rights negotiations.

Vendor Information:

Planning and Management Consultants, Ltd.
6352 South U.S. Highway 51
P.O. Box 1316
Carbondale, IL 62903
(618) 549-2832

IWRAPS Training Courses
Contact: Daniel T. Magro
NFESC Code 242
(805) 982-3529 DSN 551

C. LEAK AUDIT

The Leak Audit software is a menu-driven program designed to assist municipal water utilities to conduct audits and reduce leak losses in water distribution systems. The program uses the collected data to quantify water and revenue losses, thereby helping water utilities determine appropriate measures for reducing water and revenue losses. Although written for water utilities, the information and electronic worksheets may be useful to Navy facility managers as well.

The Leak Audit program is designed to be used with the Water Audit and Leak Detection Guidebook published by the California Department of Water Resources and the American Water Works Association (AWWA).

Vendor Information:

Department of Water Resources
Division of Local Assistance
1020 Ninth Street
P.O. Box 942836
Sacramento, CA 94236-0001

Ph: (916) 327-1649
Fax: (916) 327-1815
(Charles W. Pike)

D. IWR-MAIN, Institute for Water Resources Municipal and Industrial Needs

IWR-MAIN, or Institute for Water Resources Municipal and Industrial Needs, is a program designed for municipal and industrial utilities. It is not geared towards military facility use, in general.

E. WaterPlan

This software tool calculates the cost and savings for several water efficient measures. It was developed by AWWA, the EPA, and municipal water districts.

F. WSAP, Water Systems Analysis Program

WSAP is part of WAVE, the Water Alliance for Voluntary Efficiency, a voluntary, nonregulatory partnership program between the EPA and ho-

tels and motels. WAVE's mission is to encourage businesses and institutions to reduce water use while increasing efficiency and profitability. Government agencies are eligible to join WAVE as sponsors.

WSAP identifies water and energy savings for water consuming devices found in hotels and motels. Since these items would include toilets, faucets, laundry and kitchen water-consuming devices, the Water Systems program could be useful for federal office, residential, and laundry facilities as well.

Vendor Information:

WAVE Program Director
U.S. EPA
101 M St. SW
Mail Stop 4204
Washington, DC 20460

Ph: (202) 260-7288
Fax: (202) 260-1827

G. Residential Water Conservation Techniques

This program is a graphics-based tutorial of residential water conservation techniques. It provides potential water and revenue savings resulting from installation of efficient water-using devices.

The program is provided by the Center for Technology Transfer and Pollution Prevention (CTTPP) at Purdue University Agricultural and Biological Engineering Department. Part of the CTTPP's mission is to evaluate and develop new computer-based technology transfer opportunities. The CTTPP is supported by the U.S. EPA and the USDA.

Vendor Information:

Farm Building Plan Service
1146 AGEN Building
Purdue University
West Lafayette, IN 47907-1146

Ph: (317) 494-1173
Fax: (317) 496-1115

H. WELP, Water Efficient Landscaping Planner

The Water Efficient Landscaping Planner program covers the basics of water conserving landscaping. It describes the advantages and principles of utilizing water efficient landscaping and provides guidelines on selecting plants. It is intended for residential use, but the information can be applied to any landscaped area.

WELP is provided by the CTTPP.

Vendor Information:

See the Vendor Information listing for Residential Water Conservation Techniques above.

I. AWWA Software, American Water Works Association

AWWA, the American Water Works Association, offers a variety of utility-

oriented specialized software. These may be of limited use to you, depending on your facility situation.

WATERNET

A CD-ROM database containing some 30,000 references of literature from around the world on a wide variety of water topics. Cited journals include: Journal of American Water Works, Aqua Journal of Water Supply and Technology, and the Journal of Water Resources Planning and Management.

Well System Manager Software

This program automates record keeping and performance evaluations for water wells. It may be useful to facilities using on-site wells as a water source.

WALTER - A System to Aid Operators of Water Treatment Plants

This tool assists water operators of both large and small treatment plants to diagnose common water treatment problems associated with chemical addition, flocculation, sedimentation, filtration, and chlorination. It may be useful for facilities which operate on-site recycling or reclamation systems.

Meter Inventory Software:

Water meter record keeping tool which assists system managers to manage the inventory and maintenance records of all meters in the system. For installations with individual, on-site water meters.

Vendor Information:

American Water Works Association
6666 W. Quincy Ave.
Denver, CO 80235

Ph: (800) 926-7337

APPENDIX A

Executive Order 12902 Summary

Requirements under Executive Order 12902, "Energy Efficiency and Water Conservation at Federal Facilities"

On March 8, 1994, President Clinton signed Executive Order 12902, "Energy Efficiency and Water Conservation at Federal Facilities." The Order requires Federal facilities to assess and, where cost-effective, implement measures to improve the efficiency of Federal energy and water use. A *cost-effective measure* is defined as one having a payback period of 10 years or less, as determined by using the methods and procedures developed pursuant to 42 U.S.C. 8254 and 10 CFR 436.

Each Federal agency is to develop and implement a program to reduce energy consumption in Federal buildings 30 percent by the year 2005—relative to 1985 energy use—to the extent that measures are cost-effective. (For Federal industrial facilities, the goal is a 20-percent reduction, relative to a 1990 benchmark.) While no specific targets are set for reductions in water use, water-conservation measures are required where they are cost-effective.

The Department of Energy (DOE) will take the lead in implementing the Order through the Federal Energy Management Program. DOE must also make available by September 3, 1994, a national list of companies providing water services and a list of qualified energy service companies. The Interagency Energy Policy Committee (the 656 Committee) and the Interagency Energy Management Task Force (the Task Force) will coordinate the implementation of efficiency measures among federal agencies.

Each Federal agency responsible for managing Federal facilities must perform a *prioritization survey* by September 1995 on each facility that agency manages. A prioritization survey is a rapid facility assessment "to identify those facilities with the highest priority projects based on the degree of cost effectiveness." The prioritization surveys will also establish priorities for conducting *comprehensive facility audits*. In other words, although *all* facilities must receive *both* a prioritization survey *and* a comprehensive facility audit, the prioritization surveys determine which facilities receive comprehensive facility audits first. A comprehensive facility audit must include the following information:

- The type, size, energy use, and performance of the major energy-using systems and their interaction with the building envelope, climate and weather influences, usage patterns, and related environmental concerns.
- Appropriate energy and water conservation maintenance and operating procedures.
- Recommendations for the acquisition and installation of energy conservation measures, including solar and other renewable energy and water conservation measures.
- A strategy to implement the recommendations.

By March 8, 1995, agencies must identify, based on the prioritization surveys, their most high-priority facilities and complete at least 10 percent of the comprehensive facility audits on those facilities. Within 180 days after completion of the comprehensive facility audit, a facility must start to implement recommendations for energy efficiency, water conservation, and renewable energy technologies. Thereafter, an agency must perform comprehensive facility audits on at least 10 percent of its facilities each year.

Each Federal agency must report annually to DOE and the Office of Management and Budget on progress toward meeting the goals of the order. Agencies are encouraged to use innovative funding mechanisms, including demand side management programs, shared energy savings contracts, and energy savings performance contracts. By September 3, 1994, GSA must prepare and make available to Federal facility managers a list of all utilities that offer "no-cost" energy efficiency and water conservation audits and demand side management services and incentives.

APPENDIX B

Points of Contact

APPENDIX B
Points of Contact

Naval Facilities Engineering Service Center (NFESC)

Water Program Manager
Peter H. Hill
(805) 982-3502 FAX (805) 982-5388
DSN 551-3502 e-mail: phill@nfesc.navy.mil

Water Resources/Conservation
Daniel T. Magro
(805) 982-3529 FAX (805) 982-5388
DSN 551-3529 e-mail: dmagro@nfesc.navy.mil

Project Submission Procedures
Dave Schuelke
(805) 982-3501 FAX (805) 982-5388
DSN 551-3501 e-mail: dschuel@nfesc.navy.mil

Leak Detection Services
William C. Pierce
(805) 982-3595 FAX (805) 982-5388
DSN 551-3595 e-mail: wpierce@nfesc.navy.mil

Maria A. Zendejas
(805) 982-6072 FAX (805) 982-4931
DSN 551-6072 e-mail: mzendej@nfesc.navy.mil

Submittal Package Status/EPSS
Geoff Dann
(805) 982-1366 FAX (805) 982-5388
DSN 551-1366 e-mail: gdann@nfesc.navy.mil

Life Cycle Cost (LCC)
Michael Rocha
(805) 982-3597 FAX (805) 982-5388
DSN 551-3597 e-mail: mrocha@nfesc.navy.mil

Federal Energy Management Program (FEMP)

Energy Audits Program /Water Conservation
Ashley Houston (NREL-Denver)
(303) 384-7412 e-mail: ashley_houston@nrel.gov
FAX (202) 586-3000

LCC/ASEAM/FEDS/Workshops /Technical Tool/Test Beds
Dean DeVine
(202) 586-6784 e-mail: FEMP@tmn.com
FAX (202) 586-3000

Training Programs/Workshops
Ted Collins
(202) 586-8017 e-mail: FEMP@tmn.com
FAX (202) 586-3000

Naval Facilities Engineering Command (NAVFACENGCOM)

Energy Project Management
Joe Cloutier
(703) 325-2480 FAX (703) 325-6799
DSN 221-2480 e-mail: njcloutier@hq.navfac.navy.mil

Water Conservation Program
Harold Usher
(703) 325-0014 FAX (703) 325-6799
DSN 221-0014 e-mail: husher@hq.navfac.navy.mil

Civil Engineering Corps Officer School (CECOS)

Energy/Water Conservation Training
Gil Siqueido
(805) 982-4245 FAX (805) 982-2918
DSN 551-4245 e-mail: gsiqueido@cbcph.navy.mil

APPENDIX C

Water Survey Forms

LANDSCAPE IRRIGATION SUMMARY

Major Area	Metered (N)o or Meter Number	(M)anual or (A)utomatic	Operator (P)WC (O)ccupant (C)ontractor	Sensors (R)ain (M)oisture (N)one	Winter schedule		Summer schedule		Square Footage	Annual Consumption, if known
					Days/week	Min/Day	Days/week	Min/Day		

C-1

POINTS OF CONTACT
WATER CONSERVATION SURVEY

Base Name			
KEY PERSONNEL	Name	Phone	Fax
Public Work Officer			
Staff Civil Engineer			
Engineering Director			
Utility Director			
Water Distribution Foreman			
Water Treatment Foreman			
Waste Water Treatment Plant Foreman			
Golf Course Director			
Water/Energy Conservation Representative			
Irrigation Supervisor			
TOP TEN WATER USERS			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
MAJOR TENANT COMMANDS			

REMARKS

SOURCE WATER
WATER CONSERVATION SURVEY

SOURCE OF WATER	Pumped/ Purchased	Aquifer Name or Supplier	Prior Year Consumption	Metered?
Source 1				
Source 2				
Source 3				
Source 4				

COST OF WATER	Source 1	Source 2	Source 3	Source 4
Pump				
Electricity				
Aquifer Extraction Fees				
Well Certifications/Permits				
Labor				
Purchase				
Processing				
Labor				
Electricity				
Softener Salts				
Water Sampling				
Distribution				
Maintenance				
E/S Repairs (Breaks)				
Water Meter Reading				
Chlorination				
Flushing				
Back Flow Testing				

ACTUAL COST	MARGINAL COST

REMARKS

COOLING TOWERS
WATER CONSERVATION SURVEY

Unit Number_____ Location_____

Serving_____

Capacity/Tons_____ Concentration Ratio_____

Manufacturer_____ Model_____

Process/HVAC_____ Hours/day_____

MAKEUP

Water Source_____ Meter Number_____

Backflow protected_____ Pretreatment_____

Consumption Daily_____ Annual_____

Makeup Conductivity_____ Compressed Air Available_____

CHEMICAL TREATMENT

Biofouling Chemicals_____ Annual Cost_____

Descale Chemicals_____ Annual Cost_____

Method of control_____

FILTRATION

Type: Side Stream/Full Flow_____

BLOWDOWN

Control Type: Conductive/Timer/Fixed Rate_____

Conductivity_____ PH Level_____

Bleed off: Daily_____ Evaporation_____

LABOR

Maintenance Man hours_____ Cleaning Man hours_____

_____

_____

Sketch Layout on Back of Form

BOILER/COGENERATION
WATER CONSERVATION SURVEY

Unit Number_____ Location _____

Serving_____ Type: Steam/Hot Water_____

Fuel Type_____ Capacity_____

FEED WATER

Water Source _____ Meter Number_____

Consumption Daily_____ Annual _____

Type of treatment_____

BLOWDOWN

Amount_____ Method of control_____

CONDENSATE

Metered_____ Amount Daily_____ Annual_____

COGENERATION

Type: Turbine Diesel Boiler_____

Manufacture and Model_____ KW_____

REMARKS

_____

_____

_____

_____

_____

_____

LANDSCAPE IRRIGATION
WATER CONSERVATION SURVEY

Area Description_____

Meter Number_____ Backflow Protected_____

Manual/Automatic_____ Operator_____
(PWC/Occupant/Contractor)

Sensors Rain/Moisture_____ Square Footage_____

Water Source_____ Annual Labor M/H_____

	Number/Type of Fixtures	Summer Schedule Days/week	Summer Schedule Min/day	Winter Schedule Days/week	Winter Schedule Min/day
Station 1					
Station 2					
Station 3					
Station 4					
Station 5					
Station 6					
Station 7					
Station 8					
Station 9					
Station 10					

Application Rate:

	Winter	Summer	Total
Inches			
K/gallon			
Cubic Feet			
Acre Feet			

REMARKS_____

BASE POPULATION
WATER CONSERVATION SURVEY

FULL TIME EMPLOYEES (eight hour day)
(For calculating water use)

	Average #
DOD Civilians	
Military	
MWR/NEX	
Other	
TOTAL	

ON BASE QUARTERS

	No. of Units	Average Occupancy	% Occupancy
BEQ			
BOQ			
Enlisted Housing			
Officer Housing			
Total			

REMARKS

WASTE WATER & RECLAMATION
WATER CONSERVATION SURVEY

How much effluent is processed? _____ Kgallons per: Day Week Month

Capacity of the treatment plant? _____ Kgallons per: Day Week Month

Where is the secondary effluent discharged to? _____

_____

Is any water being processed for reclaimed purposes? _____

_____

If Yes, How Much and for what purpose:_____

_____

Is there any open or pending discharge issues for quantity or quality?_____

_____

Has an EIR or Master Plan been developed for the sewage treatment plant?_____

_____

COSTS (The following section is to determine the actual and marginal cost of processing waste water.)

Electricity cost _____ per: Month Year

Potable water: _____ Kgal per: Month Year

Chemicals _____ per: Month Year

Laboratory/Testing _____ per: Month Year

Permit Fees: _____

Discharge Fees: _____

Labor, Operation and Maintenance: _____

Solid waste disposal: _____

Reclamation Opportunities/Remarks _____

_____

_____

BUILDING SURVEY
WATER CONSERVATION SURVEY

Building Number _____ Type _____
(BEQ/BOQ/Office/Enlisted/Officer Quarters/Lodge)

Location _____ Occupants (Total) _____

Men _____ Women _____ Children _____

Meter Number _____ Annual Water Usage _____

Garbage Disposal _____ Kitchen Sink _____

Dishwasher _____ Deep Sink (Qty.) _____

Wash Machines _____ Toilets (Qty.) _____

Urinals _____ Showers _____

Sample Fixture Flow Rates

Location	Fixture	Time	Rate	Location	Fixture	Time	Rate

Wastewater _____ Recycled water use _____
(Sewer/TWTP/Septic/Other (Toilets/Urinals/Cooling Tower/Irrigation)

Remarks _____

INDUSTRIAL PROCESSES
WATER CONSERVATION SURVEY

Process	Building	Usage	Source	Effluent
Paint Stripping				
Spray Painting				
Metal Cleaning				
Metal Plating				
Autoclave				
Fume/Air Scrubbers				
Dynamotor				
Turbine Test Stands				
Water Pretreatment				
Reverse Osmosis				
Source Treatment Units				

Notes

WASH FACILITIES
WATER CONSERVATION SURVEY

Wash Rack	Building	Usage	Source	Effluent	Separator
Government Vehicles					
MWR Car Wash					
Aircraft Wash					

Notes

WATER CONSERVATION
COOLING TOWER SUMMARY

Tower No.	Serving Building	Capacity Tons	Make and Model	Metered Yes/No	Backflow Protected Yes/No	Blowdown (I)nductive (T)imer	Blowdown sent to (S)ewer (I)WTP	Makeup Conductivity CM	Daily Bleed-off E/(CR -1)	Bleed-off Conductivity CB	Conc. Ratio (CR) CB/CM	Evap. (E) M-B	Make-up (M) B+E	Current pH level	Type of Chemical Treatment	Operational time per day
	Remarks															
	Remarks															
	Remarks															
	Remarks															
	Remarks															
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APPENDIX D

References

Appendix D
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Water Conservation Opportunities

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APPENDIX E

Sample Project Submittal Packages

1391 PROJECT SUMMARY SHEET

Activity:	Naval Weapons Station, Earle Colts Neck, NJ 07702

Project Description: In the northeast section of the Mainside portion of NWS Earle, accessed by Macassar Road and Saipan Road, are 500 quarters. 300 of these were constructed by private contractors under a "Section 801", twenty-two year leased housing program and the remaining 200 quarters were constructed under a MILCON project. During a water usage audit, a sampling of the fixtures in both areas indicated that the majority of the fixtures, though relatively low in flow, do not meet the standards of the Energy Policy Act of 1992. By replacing the majority of the fixtures in these quarters, a water savings can yield enough to pay for the project in a little more than 8 years. This project suggests the replacement of all toilets, all bathroom faucet fixtures in all 500 quarters and replacing the shower heads in just the MILCON quarters.

Project Title:	Low Flow Fixture Installation MILCON/ 801 Accompanied Quarters
Project Number:	WTR-17
Annual Savings:	$62,971
Total Investment:	$517,360
SIR:	1.87
Simple Payback:	8.22 yrs
Point of Contact:	Maria Zendejas NFESC, Code 242
Phone Number:	(805) 982-6072

1391 PROJECT PACKAGE
Low Flow Fixture Installation MILCON / 801 Accompanied Quarters

1. 1391

2. 1391C

ATTACHMENTS

A. LCC SPREADSHEET

B. LIST OF ASSUMPTIONS

C. SAVINGS CALCULATIONS

D. COST ESTIMATE FORM NAVFAC 11013/7

E. POINT OF CONTACT LIST

F. REFERENCES

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Naval Weapons Station, Earle Colts Neck, NJ 07722	Low Flow Fixture Installation MILCON / 801 Accompanied Quarters.

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST
		WTR-17	$517,360.00

9. COST ESTIMATES

ITEM	UM	QUANTITY	UNIT COSTS ($)	COST $
1. Low flow Tank Toilets	EA	1,000	$254.00	$254,000.00
2. Low flow sinks and fixtures assemblies	EA	1,000	$165.50	$165,500.00
3. Low flow shower heads (only MILCON project)	EA	400	$66.25	$26,500.00
4. Sub Total				$446,000.00
5. Supervision, Inspection, and Overhead (SIOH) - (6%)				$26,760.00
6. Design Cost (10%)				$44,600.00
TOTAL COST				**$517,360.00**

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Replace all toilets, bathroom sink faucets and shower heads in the MILCON accompanied quarters and replace all toilets and bathroom sink faucets in the 801 accompanied quarters with low flow fixtures.

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION

Naval Weapons Station, Earle, Colts Neck, NJ 07722

4. PROJECT TITLE	5. PROJECT NUMBER
Low Flow Fixture Installation MILCON / 801 Accompanied Quarters	WTR-17

11. REQUIREMENT:

PROJECT: Install low flow fixtures in the bathrooms of the MILCON/ 801 accompanied housing projects at Naval Weapons Station, Earle. Project shall include; Identification and procurement of proper , cost effective low flow fixtures , Removal and disposal of the old fixtures, Installing the new fixtures and Inspection of the installations .

REQUIREMENT: Executive Order 12902 requires implementation of all water conservation projects with less than a ten year payback to be completed by year 2005. Installing low flow fixtures will save the NAVY money through the reduction in consumption in water and natural gas resources.

CURRENT SITUATION: The water conservation audit, completed 21 July, 1995 determined that the MILCON/ 801 accompanied quarters at NWS Earle have bathroom fixtures which exceed the required low flow standards.

IMPACT IF NOT PROVIDED: Without installing low flow fixtures in the MILCON/ 801 accompanied quarters, the Navy will continue to pay for lost resources.

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION

Naval Weapons Station, Earle, Colts Neck, NJ 07722

4. PROJECT TITLE	5. PROJECT NUMBER
Low Flow Fixture Installation MILCON/ 801 Accompanied Quarters	WTR-17

1. ***PROJECT:*** Install low flow fixtures in the MILCON/ 801 accompanied quarters at Naval Weapons Station, Earle. Project shall include; Selecting the proper cost effective fixtures which meet the standards for low operation, Procurement of selected fixtures, Removing and disposing of the old fixtures, Installing the new fixtures and Inspection of the new installations.

2. ***PROPOSED CONSTRUCTION:*** Install low flow fixtures in the MILCON/ 801 accompanied quarters which includes: 1000 low flow toilets, 1000 low flow bathroom sink faucets and 400 low flow shower heads.

3. ***COST ESTIMATES:*** See Attachment D

4. ***PROJECT JUSTIFICATION:*** Executive Order 12902 requires implementation of all water conservation projects with less than a ten year payback to be completed by year 2005. Installing low flow fixtures will save money and water resources.

5. ***EQUIPMENT:*** N/A

6. ***COMMON SUPPORT FACILITIES:*** N/A

7. ***EFFECT ON OTHER RESOURCES:*** The proposed project will have no effect on other resources.

8. ***PROJECT SITE:*** Naval Weapons Station, Earle, Colts Neck, NJ 07722

9. ***DEMOLITION/REASSIGNED FACILITIES:*** N/A

10. ***ECONOMIC ANALYSIS:*** See Attachment C (Savings Calculations) for a detailed analysis.

Water Savings: ***7,524.5 Kgal / yr***
Sewer Savings: ***7,524.5 Kgal / yr***
Energy Savings: ***1,975,299 BTUs / yr***
Savings: ***$ 62,971 / yr***

11. ***ENVIRONMENTAL IMPACT:*** No impacts on the environment are expected due to installing meters.

12. ***MAINTENANCE FACILITIES:*** N/A

13. ***MORALE, WELFARE, AND RECREATIONAL FACILITIES:*** N/A

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION	
Naval Weapons Station, Earle, Colts Neck, NJ 07722	
4. PROJECT TITLE	**5. PROJECT NUMBER**
Potable Water Distribution System Meter Installation	WTR-17

14. ***STORAGE FACILITIES:*** N/A

15. ***HAZARDS, ASSESSMENT AND ANALYSIS:*** N/A

16. ***DEFENSE ACCESS ROADS:*** N/A

17. ***NUCLEAR SURVIVABILITY:*** N/A

18. ***INDUSTRIAL FACILITIES:*** N/A

19. ***TELEPHONES:*** N/A

20. ***INTRUSION DETECTION SYSTEMS (IDS):*** N/A

21. ***HYPERBARICS:*** N/A

22. ***UNINTERRUPTABLE POWER SYSTEMS (UPS):*** N/A

23. ***TEMPEST SHIELDING:*** N/A

24. ***PHYSICAL SECURITY:*** N/A

25. ***PRESERVATION OF HISTORIC SITES AND STRUCTURES:*** N/A

26. ***DESIGN FOR ACCESSIBILITY OF PHYSICAL HANDICAPPED PERSONNEL:*** N/A

27. ***FLOOD PLAIN MANAGEMENT AND WETLANDS PROTECTION:*** N/A

28. ***INTERGOVERNMENTAL COORDINATION:*** N/A

29. ***PLANNING IN THE NATIONAL CAPITAL REGION:*** N/A

30. ***NATO INFRASTRUCTURE PROGRAM:*** N/A

31. ***ENDANGERED SPECIES AND OTHER NATURAL RESOURCE CONSIDERATIONS:*** N/A

32. ***GRAPHIC MATERIALS:*** N/A

ENERGY LIFE CYCLE COST ANALYSIS SUMMARY
LOW FLOW FIXTURE INSTALLATION MILCON / 801 ACCOMPANIED QUARTERS

LOCATION: NWS EARLE REGION: 1 PROJECT NO: WTR-17
CATEGORY: 20 PROJ TITLE: Water Projects FY: 1995
DATE: 06-Nov-95 ECONOMIC LIFE: 20 PREPARED BY: K.S.ARCHIBALD
STATE: NJ

1. INVESTMENT COSTS

A. CONSTRUCTION COST	$446,000		
B. SIOH (6.0%)	$26,760		
C. DESIGN COST (10%)	$44,600		FUNDING AMOUNT
D. ENERGY CREDIT CALC (1A+1B+1C)		$517,360	$517,360
E. SALVAGE VALUE OF EXISTING EQUIPMENT			
F. PUBLIC UTILITY COMPANY REBATE			
G. TOTAL INVESTMENT (1D-(1E+1F))		$517,360	

2. ENERGY SAVINGS (+) or COST (-)
ANALYSIS DATE SAVINGS, UNIT COSTS & DISCOUNTED SAVINGS

FUEL	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)
A. ELECT			$0	14.99	$0
B. DIST			$0	18.50	$0
C. RESID			$0	20.90	$0
D. NG	$11.56	721	$8,344	18.27	$152,436
E. COAL			$0	15.68	$0
F. DEMAND SAVINGS				14.88	$0
G. SUBTOTAL		721	$8,344		$152,436
	$/Mgal	Mgal/YR	SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)
H. WATER	$3,590.00	7.52	$27,013	14.88	$401,951
I. TOTAL			$35,356		$554,388

3. NON-ENERGY SAVINGS (+) or COST (-)

A. ANNUAL RECURRING (+/-)		(Sewer)	$27,615
(1) DISCOUNT FACTOR (TABLE A-2)		14.88	
(2) DISCOUNTED SAVINGS/COST (3A X 3A1)			$410,909

B. NON RECURRING SAVINGS (+) or COST (-)

ITEM	SAVINGS $ COST (1)	YEAR OF OCCURRENCE(2	DISCOUNT FACTOR (3) (TABLE A-1)	DISCOUNTED SAVINGS (+) OR COST (-) (4)
a.			1.000	$0
b.			1.000	$0
c.			1.000	$0
d. TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS/COST (3A2+3Bd4)	$410,909
4. FIRST YEAR $ SAVINGS (2I3+3A+(3Bd1/YRS ECON LIFE)	$62,971
5. SIMPLE PAYBACK = 1G/4	8.22 YR
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C)	$965,296
7. SIR (IF < 1.5 PROJECT DOES NOT QUALIFY) (SIR) = (6/1G) =	1.87

ATTACHMENT A

1391 - ATTACHMENT B
LOW FLOW FIXTURE INSTALLATION MILCON/ 801 ACCOMPANIED QUARTERS
LIST OF ASSUMPTIONS

It is assumed that the sample flow measurements taken during the water survey are typical of all fixtures in the quarters.

It is assumed that the existing fixtures in each quarters are identical in design and operation and are in the same condition of service.

It is assumed that replacement plumbing fixtures will adhere to the standards set by the Federal Energy Policy Act of 1992 which set maximum flow rates for plumbing fixtures and fittings as follows:

At feed pressure of 80 psi:
Lavatory faucets: 2.5 gallons per minute(gpm).
Lavatory replacement aerators: 2.5 gpm.
Gravity tank-type toilets: 1.6 gpm. per flush.
Flushometer tank toilets: 1.6 gpm. per flush.
Urinals: 1.0 gpm.
Showerheads: 2.5 gpm. [1]

It is assumed that each quarters is occupied 98% of the time to full occupancy.

It is assumed that the average personnel in each quarters is 2.5 children and 2 adults including 1 service personnel.

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1 State of California Water Efficiency Guide for Business Managers and Facility Engineers 10/94

1391 - ATTACHMENT C
LOW FLOW FIXTURE INSTALLATION MILCON/ 801 ACCOMPANIED QUARTERS SAVINGS CALCULATIONS

In the northeast section of the Mainside portion of NWS Earle, accessed by Macassar Road and Saipan Road, are 500 quarters. 300 of these were constructed by private contractors under a "Section 801", twenty-two year leased housing program and the remaining 200 quarters were constructed under a MILCON project. During a water usage audit, a sampling of the fixtures in both areas indicated that the majority of the fixtures, though relatively low in flow, do not meet the standards of the Energy Policy Act of 1992. By replacing the majority of the fixtures in these quarters, a water savings can yield enough to pay for the project in a little more than 8 years. This project suggests the replacement of all toilets, all bathroom faucet fixtures in all 500 quarters and replacing the shower heads in just the MILCON quarters.

The following tables are based on:

AWWA standards for residential water usage factors.
An average base occupancy rate of 98%.
An average occupancy of 3.5 dependents per domicile plus 1 service member for 16 hours in the domicile which yields an average equivalence of 4.1 persons per domicile.

WATER CONSUMPTION ACCOMPANIED HOUSING (MILCON)

MILCON PROJECT QUARTERS	QTY PER HOUSE	OCCU-PANCY RATE %	QTY PER PROJECT	FLOW RATE (gpm)	TIME PER USE (minutes)	VOLUME PER USE (gallons)	DAILY USE CYCLES PER PERSON	DAILY VOLUME PER HOUSE (gallons)	DAILY VOLUME PER PROJECT (gallons)	ANNUAL VOLUME PER PROJECT (gallons)
Qty Quarters			200							
Dependants	4.1	98	803.6							
Toilets	2		400			4.6	5	92.41	18,483	6,750,843
Bath Sinks	2		400	5	0.14	0.7	7	19.69	3,938	1,438,223
Shower	1		200	1.5	7	10.5	0.75	31.64	6,328	2,311,430
Bathtub	1		200			44	0.19	33.59	6,718	2,453,785
Wash Machine	1		200			40	0.13	20.89	4,179	1,526,277
Kitchen Sink	1		200	3	0.20	0.6	6	14.46	2,893	1,056,654
Dishwasher	1		200			14		14.00	2,800	1,022,700
TOTAL PER HOUSEHOLD (gallons)								226.68		
TOTAL PER PROJECT (gallons)									45,339	16,559,912

1391 - ATTACHMENT C (Cont.)
LOW FLOW FIXTURE INSTALLATION MILCON/ 801 ACCOMPANIED QUARTERS SAVINGS CALCULATIONS

WATER CONSUMPTION ACCOMPANIED HOUSING ('801' LEASEHOLD)

(801) LEASEHOLD PROJECT QUARTERS	QTY PER HOUSE	OCCU-PANCY RATE %	QTY PER PROJECT	FLOW RATE (gpm)	TIME PER USE (minutes)	VOLUME PER USE (gallons)	DAILY USE CYCLES PER PERSON	DAILY VOLUME PER HOUSE (gallons)	DAILY VOLUME PER PROJECT (gallons)	ANNUAL VOLUME PER PROJECT (gallons)
Qty Quarters			300							
Dependants	4.1	98	1,205.4							
Toilets	2		600			3.6	5	72.32	21,697	7,924,902
Bath Sinks	2		600	3	0.14	0.42	7	11.81	3,544	1,294,401
Shower	1		300	4	7	28	0.75	84.38	25,313	9,245,719
Bathtub	1		300			44	0.19	33.59	10,077	3,680,677
Wash Machine	1		300			40	0.13	20.89	6,268	2,289,416
Kitchen Sink	1		300	2.5	0.2	0.5	6	12.05	3,616	1,320,817
Dishwasher	1		300			14		14.00	4,200	1,534,050
TOTAL PER HOUSEHOLD (gallons)								249.04		
TOTAL PER PROJECT (gallons)									74,715	27,289,982

1391 - ATTACHMENT C (Cont.)
LOW FLOW FIXTURE INSTALLATION MILCON/ 801 ACCOMPANIED QUARTERS
SAVINGS CALCULATIONS

WATER SAVINGS ESTIMATE
- ACCOMPANIED HOUSING FIXTURE REPLACEMENT [2]

	CAP	TOILET (TANK) [A]								SHOWERS [B]			
Bldg # Location	People	Qty	Vol gal per cycle	Vol gal Total	Vol @ 1.6 gal	Qty	Vol gpm	Vol gal Total	Vol @ 2.2 gpm	Qty	Vol gpm	Vol gal total	Vol @ 2.5 gal
MILCON HOUSING	803.6	400	4.5	18,081	6,429	400	5.0	3,938	1,733	400	3.0	12,657	10,547
801 LEASEHOLD	1205.4	600	4.8	5,554	1,851	600	3.0	3,544	2,599				
Total	2,009	1,000		23,635	8,280	1,000		7,482	4,332	400		12,657	10,547

Project Item	Qty	Unit	Total
Toilet Retrofits [H]	1000	$254.00	$254,000.00
Sinks [I]	1000	$165.50	$165,500.00
Shower Heads [J]	400	$66.25	$26,500.00
TOTAL PROJECT			$446,000.00

Current Daily Total		43,774
With Low Flow Devices		23,159
Daily Saving Gallons		20,615
Annual Saving Gallons		7,524,475
Annual Savings @ $7.26 per Kgallon [D]		$54,628
Daily Hot Water Savings (gallons) [E]		2,630
BTU saved per day [F]		1,975,299
Annual Savings [G]	1,029,977	$8,343
TOTAL ANNUAL SAVINGS		$62,971

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2 Figures are based on AWWA standards:
(Average Values)

A Toilet use = 5 flushes per person per day.

B Shower use based upon seven minutes per shower and 0.75 showers per day per person.

C Sink estimate based on 7 uses per person per day and 0.14 minutes per use.

D Comparative cost for the Colts Neck area of $3.59 per Kgallon for water and $3.67 per Kgallon for sewer

E Hot water savings based upon 50% of sink usage plus 50 % of shower usage.

F BTU based on increase in temperature of 90 degrees (F) above 70 degrees (F) and 8.34516 lbs of water per gallon .(1 BTU=1 lb of water increased to 1 degree F.)

G Annual savings based on 70% efficient use of natural gas heating at $0.81 per 100 cu ft of natural gas. (1 cu ft = 1,000 BTU)

H Toilet retrofit based on Means152-180-1100 & 020-724-1400 pricing for removal and installation of low flow toilet.

I Sink Faucet retrofit based on Means 152-48-5500 & 152-180-1100 pricing for removal and installation of low flow fixture.

J Shower Head retrofit based on Means 152-148-5500 pricing for removal and installation of low flow fixture.

1391 - ATTACHMENT C (Cont.)
LOW FLOW FIXTURE INSTALLATION MILCON/ 801 ACCOMPANIED QUARTERS
SAVINGS CALCULATIONS

The potential savings by installing low flow fixtures are:

Water 7,524.5 Kgal x $3.59 *(cost per Kgal)* ***= $ 27,012.96*** *(savings per year)*
Sewer 7,524.5 Kgal x $3.67 *(cost per Kgal)* ***= $ 27,614.92*** *(savings per year)*
Total Savings = $27,012.96 + $27,614.92 = $54,627.88

Energy savings due to reduction in hot water consumption:

Annual BTUs **=1,975,299**
Annual cu-ft natural gas = **1,029,977**
Annual natural gas savings at **$0.81 per 100 cu-ft = *$ 8,342.81***

The cost to install fixtures:

Design = $ 44,600
Material Cost ***= $ 224,100***
Labor Cost ***= $ 221,900***
Supervision Inspection & Overhead ***= $ 26,760***

Cost summation:

$ 44,600+$ 224,100+$ 221,900+$ 26,760= $ 517,360

Low flow fixture installation project cost-effectiveness

Value of water not expended ***= $ 54,628***
Value of energy not expended ***= $ 8,349***
Cost to install low flow fixtures ***= $ 517,360***

NAVFAC 11013/7 (1-78)	COST ESTIMATE	DATE PREPARED: 06 NOV 95	SHEET 1 OF
ACTIVITY AND LOCATION - Naval Weapons Station, Earle Colts Neck, New Jersey		CONSTRUCTION CONTRACT #	IDENTIFICATION # WTR-17
PROJECT TITLE - Low Flow Fixture Installation MILCON/ 801 Accompanied Quarters		ESTIMATED BY S. Archibald, S.B.A.R.	CATEGORY CODE # 211-01
		STATUS OF DESIGN	JOB ORDER NUMBER

Item Description	Quantity		Material Cost		Labor Cost		Engineering Estimate	
	NUMBER (a)	UNIT (b)	UNIT COST (c)	TOTAL (d)	UNIT COST (e)	TOTAL (f=a*e)	UNIT COST (g=c+e)	TOTAL (h=g*a)
Low Flow Toilets (Means 152-180-1100)	1000	EA	145.00	145,000.00	79.50	79,500.00	224.50	224,500.00
Toilet Removal (Means 020-724-1400)	1000	EA	0.00	0.00	29.50	29,500.00	29.50	29,500.00
Sink Low Flow Faucet s (Means 152-148-5500 Material) (Means 152-180-1100 Installation Labor)	1000	EA	56.50	56,500.00	79.50	79,500.00	136.00	136,000.00
Sink Faucet Removal (Means 020-724-1400)	1000	EA	0.00	0.00	29.50	29,500.00	29.50	29,500.00
Low Flow Shower Head (Means 152-148-5500)	400	EA	56.50	22,600.00	0.00	0.00	56.50	22,600.00
Low Flow Shower Head Removal/Replacement (Means 152-148-5500)	400	EA	0.00	0.00	9.75	3,900.00	9.75	3,900.00
Sub Total Labor/Materials				224,100.00		221,900.00		0.00
SUBTOTAL								**446,000.00**
SUPERVISION INSPECTION, AND OVERHEAD (SIOH) - (6%)								26,760.00
DESIGN COST (10%)								44,600.00
TOTAL								**517,360.00**

1391 - ATTACHMENT E
LOW FLOW FIXTURE INSTALLATION MILCON/801 ACCOMPANIED QUARTERS
POINT OF CONTACT LIST

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1391 - ATTACHMENT F
LOW FLOW FIXTURE INSTALLATION
MILCON/ 801 ACCOMPANIED QUARTERS

REFERENCES

- Water Audits and Leak Detection AWWA M36
  American Water Works Association

- Means Mechanical Cost Data 1995, Means Southam Construction Information Network

- State of California Water Efficiency Guide for Business Managers and Facility Engineers
  10/94

1391 PROJECT SUMMARY SHEET

Activity:	Naval Weapons Station, Earle Colts Neck, NJ 07722

Project Description: Construct a new condensate collection and return system on piers 2 and 4 to facilitate recycling expended water and steam to the boiler plants. The project shall include engineering of the new piping system, drawings for new construction, installation of new piping, connection to the condensate and make up water system in the boiler plants, and testing procedures.

Project Title:	Condensate Return System Piping Installation
Project Number:	WTR-18
Annual Savings:	$113,415
Total Investment:	$169,166
SIR:	11.44
Simple Payback:	1.49 years
Point of Contact:	Maria Zendejas NFESC, Code 242
Phone Number:	(805) 982-6072

1391 PROJECT PACKAGE
CONDENSATE RETURN SYSTEM PIPING INSTALLATION

1. 1391

2. 1391C

ATTACHMENTS

A. LCC SPREADSHEET

B. LIST OF ASSUMPTIONS

C. SAVINGS CALCULATIONS

D. COST ESTIMATE FORM NAVFAC 11013/7

E. POINT OF CONTACT LIST

F. REFERENCES

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Naval Weapons Station, Earle Colts Neck, NJ 07722	Condensate Return System Piping Installation

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST
		WTR-18	$ 169,167

9. COST ESTIMATES

ITEM	UM	QUANTITY	UNIT COSTS ($)	COST $
1. Piping	LF	2,500	9.66	$24,150.00
2. Fittings	EA	100	42.85	$4,285.00
3. Pipe Fitter	HR	80	38.00	$3,040.00
4. Pipe Insulation	LF	2,500	4.13	$10,325.00
5. Valve Isolation	EA	8	36.95	$295.60
6. Pipe Supports/Hangers	EA	250	11.80	$2,950.00
7. Flexible Hose	EA	6	620.00	$3,720.00
8. Subtotal				$48,765.60
9. System Test (10%)				$4,876.56
10. Contingency (Equipment Rental, Working Under Pier)(25%)				$12,191.40
11. Ships Drain Modifications	EA	4	20,000.00	$80,000.00
12. Supervision, Inspection, and Overhead (SIOH) - (6%)				$8,750.01
13 DESIGN COST (10%)				$14,583.36
14. TOTAL COST				$169,166.93

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Design and install a piping system to collect and recirculate water and steam discharged from the steam operated components on the piers and aboard ships moored along side at Naval Weapons Station, Earle. Project shall include: designing of piping system, installation of piping and fittings to connect the component outlet to the boiler plant, developing a piping system Test Plan and conducting a full system test.

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION

Naval Weapons Station, Earle, Colts Neck, NJ 07722

4. PROJECT TITLE	5. PROJECT NUMBER
Condensate Return System Piping Installation	WTR-18

11. REQUIREMENT:

PROJECT: Install a new piping system to collect and return condensate from steam operated components on the piers and ships moored to the pier at Naval Weapons Station, Earle. Project shall include: Designing a piping system, installing new piping and fittings, developing a piping system test plan and conducting a full system test.

REQUIREMENT: Executive Order 12902 requires implementation of all water conservation projects with less than a ten year payback to be completed by year 2005. Installing a new condensate collection piping system will save money and water resources. In addition to conserving water resources, recovering and recirculating condensate will significantly reduce the amount of energy required to produce steam.

CURRENT SITUATION: The water conservation survey, completed 21 July 1995, determined that NWS Earle was discharging steam and condensate from steam operated components and facilities on the piers and hotel services of ships moored to the piers into the bay. Not returning this steam and condensate to the boiler plant for use as boiler feed water requires the use of potable water for all steam generation. Using potable water for all steam generation requires more boiler water chemicals and more fuel. Water consumption is equal to steam output. In addition to the expense associated with not reusing the condensate, all water that enters the boiler must be demineralized which adds significantly to the cost of this volume of water.

IMPACT IF NOT PROVIDED: Without completing this piping INSTALLATION the Navy will continue to pay for lost resources.

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION

Naval Weapons Station, Earle, Colts Neck, NJ 07722

4. PROJECT TITLE	5. PROJECT NUMBER
Condensate Return System Piping Installation	WTR-18

1. ***PROJECT:*** Install a new piping system to collect steam and condensate from pier facilities and ships moored at the piers and return it to the boiler plants at Naval Weapons Station, Earle. Project shall include: Designing a piping system, installing new piping and fittings, developing a piping system test plan and conducting a full system test.

2. ***PROPOSED CONSTRUCTION:*** Install new piping and fittings to collect condensate and return it to the boiler plant for reuse as boiler feed water.

3. ***COST ESTIMATES:*** See Attachment D

4. ***PROJECT JUSTIFICATION:*** Executive Order 12902 requires implementation of all water conservation projects with less than a ten year payback to be completed by year 2005. Installation of the new condensate return system and modifying the existing boiler feed water system creating a closed loop system will save money , boiler chemicals, fuel and water resources.

5. ***EQUIPMENT***: N/A

6. ***COMMON SUPPORT FACILITIES:*** N/A

7. ***EFFECT ON OTHER RESOURCES:*** The proposed project will reduce the man power required to treat boiler water, transport fuel to the boiler plants and reduce sewage charges as currently sewage charges are computed including charges for water used in the boilers and not returned to the sewage system.

8. ***PROJECT SITE:*** Naval Weapons Station, Earle, Colts Neck, NJ 07722

9. ***DEMOLITION/REASSIGNED FACILITIES:*** **N/A**

10. ***ECONOMIC ANALYSIS:*** See Attachment C (Savings Calculations) for a detailed analysis.

Water Savings:	*12,515 Kgallons/year*
	$44,929
Fuel Savings:	*134,287 gallons/year*
	$68,487
Total Savings:	*$113,415 per year*

11. ***ENVIRONMENTAL IMPACT:*** No impacts on the environment are expected during this modification.

12. ***MAINTENANCE FACILITIES:*** N/A

13. ***MORALE, WELFARE, AND RECREATIONAL FACILITIES:*** N/A

1. COMPONENT	FY 95 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		06 NOV 95

3. INSTALLATION AND LOCATION	
Naval Weapons Station, Earle, Colts Neck, NJ 07722	
4. PROJECT TITLE	**5. PROJECT NUMBER**
Condensate Return System Piping Installation	WTR-18

14. *STORAGE FACILITIES:* N/A

15. *HAZARDS, ASSESSMENT AND ANALYSIS:* N/A

16. *DEFENSE ACCESS ROADS:* N/A

17. *NUCLEAR SURVIVABILITY:* N/A

18. *INDUSTRIAL FACILITIES:* N/A

19. *TELEPHONES:* N/A

20. *INTRUSION DETECTION SYSTEMS (IDS):* N/A

21. *HYPERBARICS:* N/A

22. *UNINTERRUPTABLE POWER SYSTEMS (UPS):* N/A

23. *TEMPEST SHIELDING:* N/A

24. *PHYSICAL SECURITY:* N/A

25. *PRESERVATION OF HISTORIC SITES AND STRUCTURES:* N/A

26. *DESIGN FOR ACCESSIBILITY OF PHYSICAL HANDICAPPED PERSONNEL:* N/A

27. *FLOOD PLAIN MANAGEMENT AND WETLANDS PROTECTION:* N/A

28. *INTERGOVERNMENTAL COORDINATION:* N/A

29. *PLANNING IN THE NATIONAL CAPITAL REGION:* N/A

30. *NATO INFRASTRUCTURE PROGRAM:* N/A

31. *ENDANGERED SPECIES AND OTHER NATURAL RESOURCE CONSIDERATIONS:* N/A

32. *GRAPHIC MATERIALS:* N/A

ENERGY LIFE CYCLE COST ANALYSIS SUMMARY
CONDENSATE RETURN SYSTEM

LOCATION: NWS EARLE REGION: 1 PROJECT NO: WTR-18
CATEGORY: 2 PROJ TITLE: Water Projects FY: 1995
DATE: 06-Nov-95 ECONOMIC LIFE: 20 PREPARED BY: P.L.BLUNTSCHLY
STATE: NJ

1. INVESTMENT COSTS

A. CONSTRUCTION COST	$145,833		
B. SIOH (6.0%)	$8,750		
C. DESIGN COST (10%)	$14,583		FUNDING AMOUNT
D. ENERGY CREDIT CALC (1A+1B+1C)		$169,166	$169,166
E. SALVAGE VALUE OF EXISTING EQUIPMENT			
F. PUBLIC UTILITY COMPANY REBATE			
G. TOTAL INVESTMENT (1D-(1E+1F))		$169,166	

2. ENERGY SAVINGS (+) or COST (-)
ANALYSIS DATE SAVINGS, UNIT COSTS & DISCOUNTED SAVINGS

FUEL	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)
A. ELECT			$0	14.99	$0
B. DIST	$5.20	13,160	$68,487	18.50	$1,267,002
C. RESID			$0	20.90	$0
D. NG			$0	18.27	$0
E. COAL			$0	15.68	$0
F. DEMAND SAVINGS				14.88	$0
G. SUBTOTAL		13,160	$68,487		$1,267,002
	$/Mgal	Mgal/YR	SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)
H. WATER	$3,590.00	12.52	$44,929	14.88	$668,541
I. TOTAL			$113,415		$1,935,543

3. NON-ENERGY SAVINGS (+) or COST (-)

A. ANNUAL RECURRING (+/-)		
(1) DISCOUNT FACTOR (TABLE A-2)	14.88	
(2) DISCOUNTED SAVINGS/COST (3A X 3A1)		$0

B. NON RECURRING SAVINGS (+) or COST (-)

ITEM	SAVINGS $ COST (1)	YEAR OF OCCURRENCE(2	DISCOUNT FACTOR (3) (TABLE A-1)	DISCOUNTED SAVINGS (+) OR COST (-) (4)
a.			1.000	$0
b.			1.000	$0
c.			1.000	$0
d. TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS/COST (3A2+3Bd4)	$0
4. FIRST YEAR $ SAVINGS (2I3+3A+(3Bd1/YRS ECON LIFE)	$113,415
5. SIMPLE PAYBACK = 1G/4	1.49 YR
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C)	$1,935,543
7. SIR (IF < 1.5 PROJECT DOES NOT QUALIFY) (SIR) = (6/1G) =	11.44

ATTACHMENT A

1391 - ATTACHMENT B
CONDENSATE RETURN SYSTEM PIPING INSTALLATION
LIST OF ASSUMPTIONS

The condensate return system will be cost effective without full ships participation.

An Alteration Equivalent to Repair (AER) to modify hotel services drain piping for the ships home ported at NWS Earle can be approved and completed in a timely manner.

Modification of ships drain piping will not exceed $20,000 for each of the four ships home ported at NWS Earle.

1391 - ATTACHMENT C
CONDENSATE RETURN SYSTEM PIPING INSTALLATION
SAVINGS CALCULATIONS

For the period of June 1 through 14, boilers 1 & 2 on Pier 2 used an average of 17,145 gallons per day. This was during a light load condition with mild weather and two ships berthed. With a winter load and with a full complement of ships moored at the Piers, steam requirements would be considerably higher. An assumption can be made that both boiler plants could use a total of 50,000 gallons per day for make up water. Assuming that the boiler plant on Pier 4 used the same amount of water as Pier 2 and the annual average is about 25% higher than that of the June time frame, then the following calculation applies:

17,145 gal/day x 2 plants = 34,290 gal/day
34,290 x 1.25 percent = 42,862 gal/day
42,862 gal/day x 365 days/year = 15,644,630 gallons/year

A condensate return system for both boiler plants with full ship participation, would result in a significant reduction in make-up water requirements, boiler treatment chemicals and fuel consumption. Assuming 90% of the steam could be returned as condensate and allowing 10% for boiler blow down, an 80% reduction in make-up water use could be achieved. Condensate returning to the plant would be approximately 180°F and potable water entering the plant will average 54° F. a temperature differential (Δ^T) of 126°F will be achieved. Boiler efficiency of 70% is reasonable. Using these assumptions, savings can be calculated as follows:

15,644,630 gallons/year x 0.80 return recovery = 12,515,704 gal savings

12,515,704 gal savings x 8.34516 pounds/gal = 104,445,552 lbs/year

104,445,552 lb of H^2O x 126 ° Δ^T = 13,160,139,601 BTU/year savings

13,160,139,601 BTU ÷ 98,000 BTU/gal[1] = 134,287 gal/year fuel savings

134,287 gal x $0.514/gal = $69,023 annual fuel savings

Note: 1 BTU per gal is for diesel fuel as referenced in STEAM its (sic) Generation and Use, Babcock & Wilcox 1978

THE POTENTIAL SAVINGS BY INSTALLING THE NEW PIPING SYSTEM ARE:

Water ***12,515 Kgal/year x $3.59 per Kgal = $44,929 (savings per year)***

Fuel ***134,287 gal/year x $0.51 per gal = $68,487 (savings per year)***
Total Savings = $113,415 Per Year

Wc = Variable cost of water (purchased price) [4]

Vwr = (44.59 gpm)(3.23 ac-ft/gpm)($185/ac-ft)

Vwr = $ 26,644.75

THE COST OF REPAIRING LEAKS IS CALCULATED AS FOLLOWS:

Note: The following information is to demonstrate that the true savings of leak detection is more than just the cost of saved water. Example; savings will be realized by not performing emergency leak repairs at overtime labor rates.

The labor and material cost of excavating and repairing leaks now and the savings resulting from not having to perform leak repairs in the future are not included in the 1391 calculations. This is because values realized after the survey and repairs may vary from the examples.

The California Department of Water Resources conducted an economic analysis and found that the major benefit of a leak detection program is the avoided repair costs (leaks repaired in the future) as a result of the program. "Since leaks are continually discovered and repaired in the normal course of the utility's operation, the leaks found in the program would have eventually been repaired at some time in the future. If these leaks are repaired as part of a leak detection program, the utility would avoid the expense of repairing them as they are discovered accidentally. These savings in future repair cost, which are often overlooked when estimating the savings from leak detection are made, can often be nearly as great as the cost of repairing the leak as part of the program. The real cost of repairing a leak in the program is generally very small".[5]

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[4] AWWA M36 formula; water purchase price + operating cost per unit of water

[5] Water Audit and Leak Detection Guidebook, California Department of Water Resources (revised June 1992)

NAVFAC 11013/7 (1-78)	COST ESTIMATE	DATE PREPARED: 06 NOV 95	SHEET 1 OF
ACTIVITY AND LOCATION - **Naval Weapons Station, Earle Colts Neck, New Jersey**		CONSTRUCTION CONTRACT #	IDENTIFICATION # **WTR-18**
PROJECT TITLE - **Condensate Return System Piping Installation**		ESTIMATED BY **P. Bluntschly, S.B.A.R.**	CATEGORY CODE # **211-01**
		STATUS OF DESIGN	JOB ORDER NUMBER

Item Description	Quantity		Material Cost		Labor Cost		Engineering Estimate	
	NUMBER (a)	UNIT (b)	UNIT COST (c)	TOTAL (d)	UNIT COST (e)	TOTAL (f=a•e)	UNIT COST (g=c+e)	TOTAL (h=g•a)
Piping 1-1/2 (Means 151-701-2060)	2,500	LF	3.42	8,550.00	6.24	15,600.00	9.66	24,150.00
Fittings (Means 151-700-3090)	100	EA	6.30	630.00	36.55	3,655.00	42.85	4,285.00
Pipe fitter layout	80	HR	0.00	0.00	38.00	3,040.00	38.00	3,040.00
Piping insulation(Means 155-651-7370)	2,500	LF	2.01	5,025.00	2.12	5,300.00	4.13	10,325.00
Valve Isolation (Means 156-240-8100)	8	EA	18.95	151.60	18.00	144.00	36.95	295.60
Pipe Supports/Hangers (Means 151-901-2920)	250	EA	8.00	2,000.00	3.80	950.00	11.80	2,950.00
Flexible Hose	6	EA	600.00	3,600.00	20.00	120.00	620.00	3,720.00
(SUBTOTAL MATERIAL & LABOR)				19,956.60		28,809.00		48,765.60
System Test and Procedural Review (10%)								4,876.56
CONTINGENCY (Equipment Rental, Working Under Pier etc) (25%)								12,191.40
Ship Drain Piping Modification	4	EA	20,000.00	80,000.00				80,000.00
SUPERVISION, INSPECTION, AND OVERHEAD (SIOH) - (6%)								8,750.01
DESIGN COST (10%)								14,583.36
TOTAL								169,166.93

1391 - ATTACHMENT E
CONDENSATE RETURN SYSTEM PIPING INSTALLATION
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1391 - ATTACHMENT F
REFERENCES

- Means Mechanical Cost Data 1995, Means Southam Construction Information Network
- STEAM, its (sic) Generation and Use, Babcock & Wilcox 1978